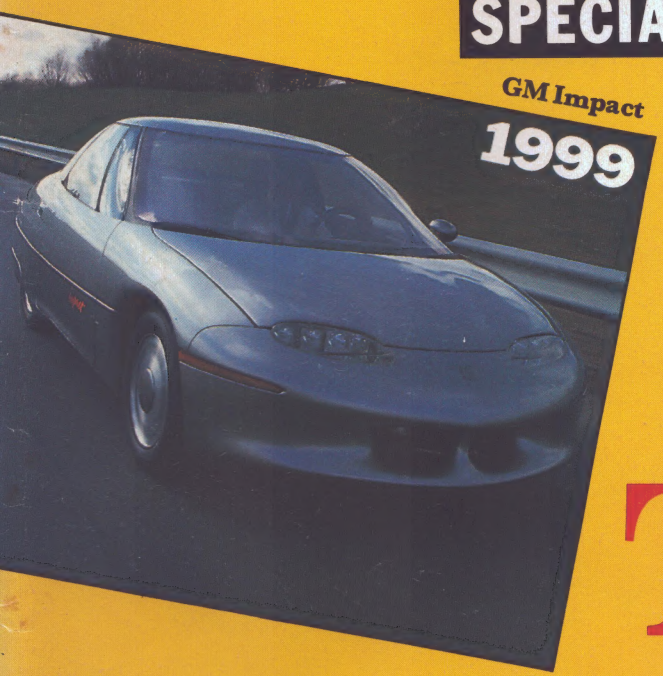
car

SPECIAL SUPPLEMENT



THE CAR IN THE FUTURE

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Intelligent, high performance executive with a mind of his own.

The Maxima is *the* executive saloon for the discerning individual.

An elegantly styled, aerodynamic thoroughbred, whose sophisticated network of computers provide it with a 'mind' of its own, constantly monitoring engine and transmission performance.

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Intelligent, high performance executive with a mind of its own.

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Like remote control, alarm activating central locking, air conditioning, cruise control, electric windows and door mirrors, electrically heated and adjusted front seats and stereo radio/cassette.

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*Where conditions allow.

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know how.

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Setting the Scene

CAR COMPANY PRODUCT planners – in effect, crystal ball gazers who try to predict what motorists will want in the future – have suddenly found their jobs just a little easier. The major issue of the '90s, and next century, has recently emerged with unusual clarity. It is the environment, and its protection.

Future cars must use energy more sparingly, both in the rate that they use fuel, and the manner in which they are made. Equally, the car's role in society must change. Cars should be used less.

This need not be bad news for the motorist, or for the enthusiast. Far more worrying would be if most governments and most car companies continued to do little, the policy of the past decade. Continuing inertia would mean increasing the vilification of the car; it would mean hopelessly clogged roads; it would result in cities unfit either for people or their cars; driving would become more of a drudge, even more frustrating. Continuing apathy would endanger the survival of the car. Motoring might be killed by its own popularity.

It is precisely because of its popularity, and its many virtues (personal mobility, convenience, the freedom it offers, and the fun), that the private car should be preserved. And because of its importance to national economies, because it employs so many people, and because the big car companies carry such power, the private car will be preserved.

Yet it must also be fundamentally improved, and at last the big car companies seem to have grasped this. Car companies, like any other big business, are more concerned with greenbacks, than green issues. They are not particularly socially responsible. Yet they are socially aware. If their customers tell them they want greener cars, and if governments wield big sticks to reinforce the message, they'll give us greener cars.

Because car makers are being forced to change, the coming decades will probably be the most revolutionary in the history of motoring. Although you may wonder where the recent evidence is, most car companies are awash with engineering and design talent. Potentially seminal cars are being designed every day. Yet, for too many years, this latent brilliance has been trammelled by unduly conservative management: car companies have been making profits, so there has been little incentive for altering course. The new need for change should liberate this talent.

We will see new shapes, new engines, new solutions. After years of being offered cars that are, more or less, clones of each other, we should see some innovation; some genuinely intriguing designs. Nothing forces the pace like necessity.

We will see new cleaner petrol engines, promising no loss in performance. We will see practical, cleaner alternatives to petrol and diesel fuels. At last, we will see new types of engines. We will also see cars using more than one type of engine: a clean one for the city, a stronger one for the country. Long term, we should see pollution-free cars – using perhaps hydrogen, or solar power. All are dealt with in this supplement.

We will also see more imagination in car design. Cars will become softer in shape but, conversely, sharper in air penetration. They will get lighter (reversing the shameful trend of the '80s, when cars actually put on bulk). Toyota estimates that a 10-percent drop in weight means an eight-percent improvement in fuel consumption.

Cars will rely far more on electronics, to increase engine efficiency, safety (anti-lock brakes are likely to proliferate), and to help us avoid traffic jams. Guidance systems – effectively, electronic A-Zs which store maps of all British towns and country roads – will be marketed shortly. Longer term – Ford's European chairman Lindsey Halstead predicts we'll have to wait about 15 years – cars should be able to drive themselves. You'll simply switch your car onto auto pilot, and have a kip or do some work.

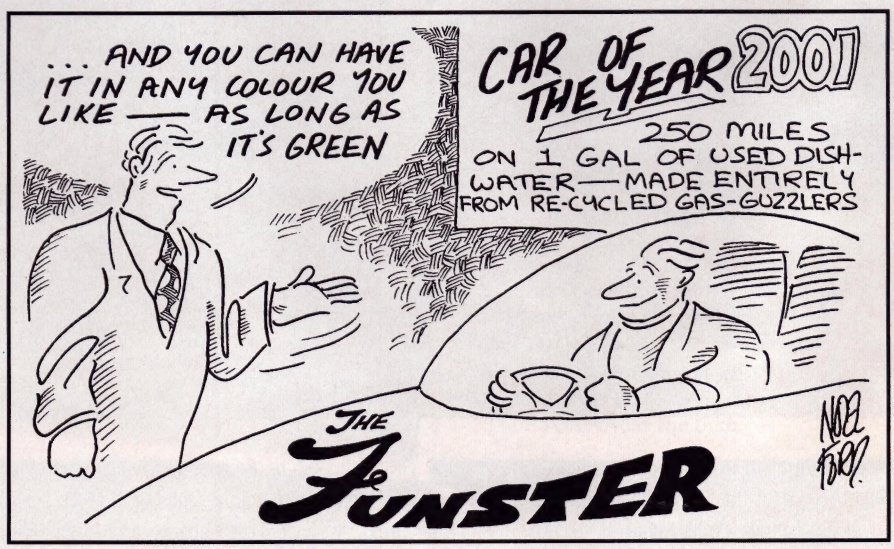
Cars of the future will be more distinctive. More body variants will be offered as manufacturers chase new niches, necessary to court an increasingly affluent and more discerning public (and one likely to have more leisure time). We can expect more recreational vehicles, designed to be fun, rather than utilitarian. We can expect a greater choice of cars. And we can also expect to see more cars.

Yet motoring, I believe, will also be more fun. For this to happen, the role of the car, in society, will have to change. We have to use our cars less, and use them differently. We must be tempted to forego our cars when they are at their least efficient and least appealing (such as in day-to-day commuting, long-distance business trips, and inner-city motoring), so as to ensure their survival for the occasions when private transport is essential or pleasurable.

I envisage motoring becoming less of a necessity and more of a recreational pursuit. And what's wrong with that? Public transport is potentially a more efficient and more comfortable way of moving people into, and around, cities. Or in conveying them on long-haul inter-city journeys. But it has to be better integrated; it has to be cleaner; it has to be more attractive; services have to be more frequent. It also has to be government-funded, and cheaper, for public transport should be a state service, not a government money-spinner. The changes needed to revolutionise public transport in Britain are at least as far-reaching as those necessary to revolutionise the car, and its usage.

But it will take more than cleaner trains, better buses or a new form of urban transport, to dissuade people from commuting in their cars. Such is the appeal of the motor car. Higher fuel costs, stricter inner-city parking restrictions, higher taxes for less fuel-efficient cars, tolls for entering big conurbations, and perhaps even a ban on cars in inner-city areas. All are worth considering, and some will no doubt be necessary, if motoring is going to continue to offer the pleasures next century, that it has during this one.

by Gavin Green
Editor of CAR Magazine



Noel Ford

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The two luxury cars that are capturing the German imagination.

There they were, West and East Germany's finest. Poignantly, standing along a stretch of the fast-disappearing Berlin Wall.

Throughout the day, a steady stream of East Germans came along to sit in it, admire it, wonder at it, touch it – the latest Trabant 601 de-luxe, that is.

The £40,000 worth of high technology next to it may just as well have come from another world as another country.

Curiously, the two cars have striking similarities. For example, the Trabant's bodywork is a combination of cotton and plastic, which renders it rust-proof.

The new Audi V8 too, has a rust-proofed body, although Audi has opted for more substantial galvanized steel instead. And, by zinc galvanizing all the bare metal, Audi is able to offer a 10 year guarantee against rusting, which should see you nicely into the next millennium.

The Trabant features a new 1100cc environmentally-

*PRICES ARE CORRECT AT TIME OF GOING TO PRESS AND EXCLUDE NUMBER PLATES

friendlier engine. (In comparison to the old 2-stroke power plant, which ran on a combination of petrol and oil.)

The engineers at Audi, too, have cast an eye to the environment. As with all Audi models, the V8 comes with the latest 3-way catalytic converter technology as standard, which reduces toxic pollutants by up to 95%.

For the past six years they've spent time perfecting the revolutionary 3.6 litre, 32 valve, V8 engine.

This is arguably the quietest, smoothest, most advanced engine in any saloon today.

When it comes to luxury fittings both cars have their share. The Trabant, for example, boasts textile floor covering and a two-tone horn.

Standard equipment on the V8 includes quattro four-wheel drive with electronic automatic transmission, ABS, cruise-control, climate control air-conditioning, leather upholstery, on-board computer and six-speaker stereo system.

Not forgetting Audi's unique Procon-Ten safety system. This pre-tensions the seat belts and pulls the steering column away from the driver in the event of a frontal impact.

Apparently none of this means too much to the East Germans at the moment, but we're sure it's just another barrier that they'll soon surmount.

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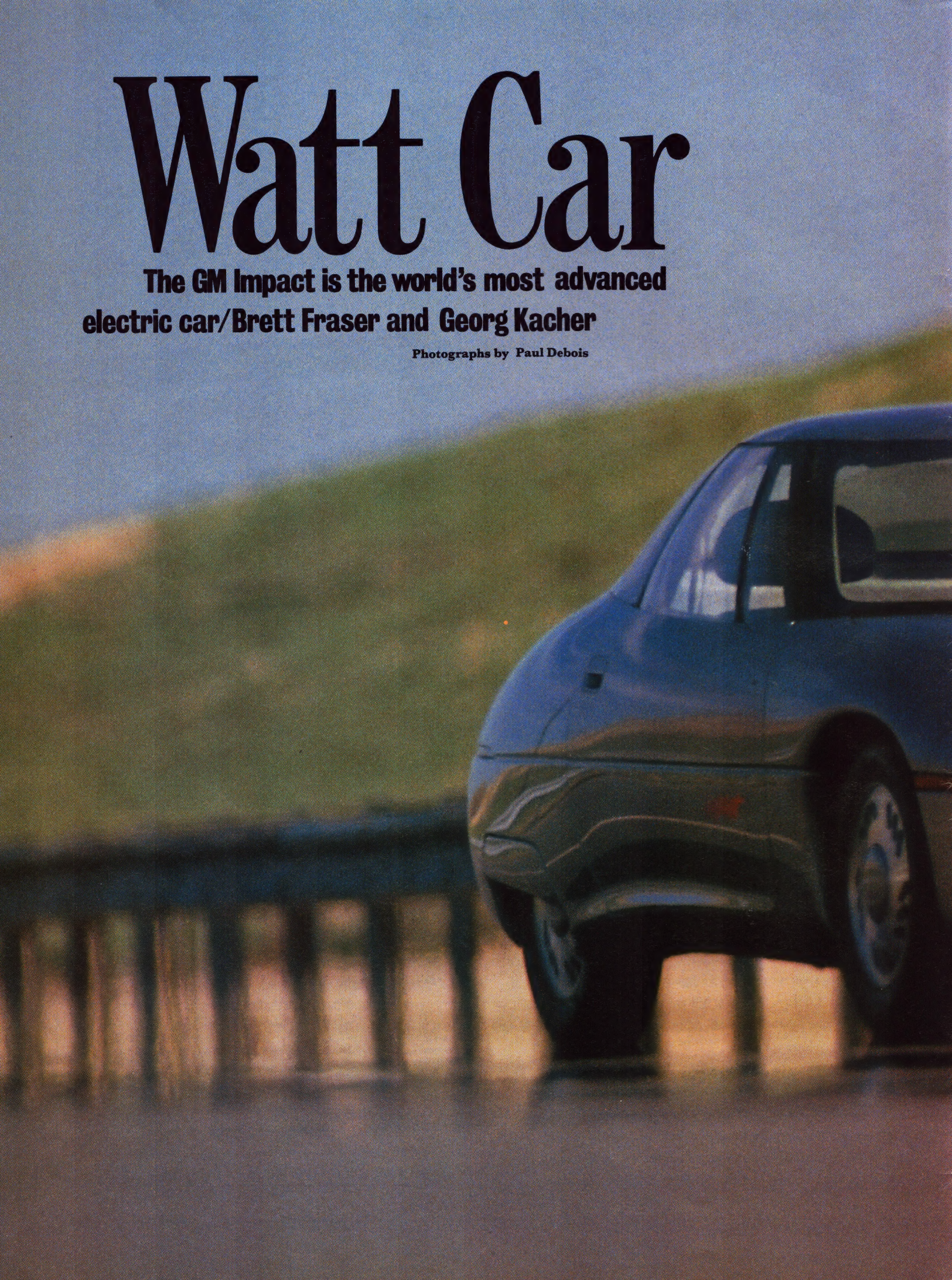
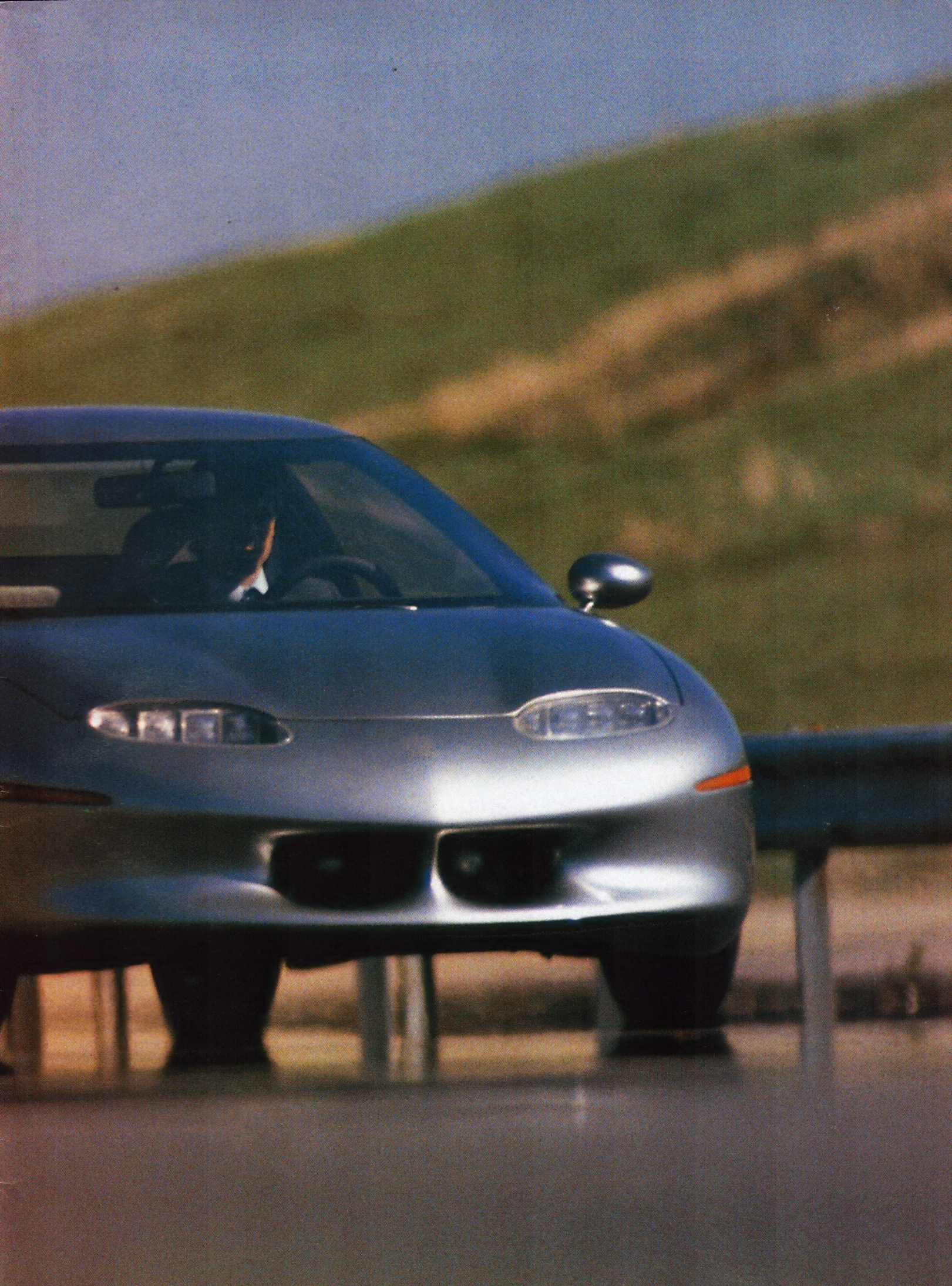
Watt Car

The GM Impact is the world's most advanced electric car/Brett Fraser and Georg Kacher

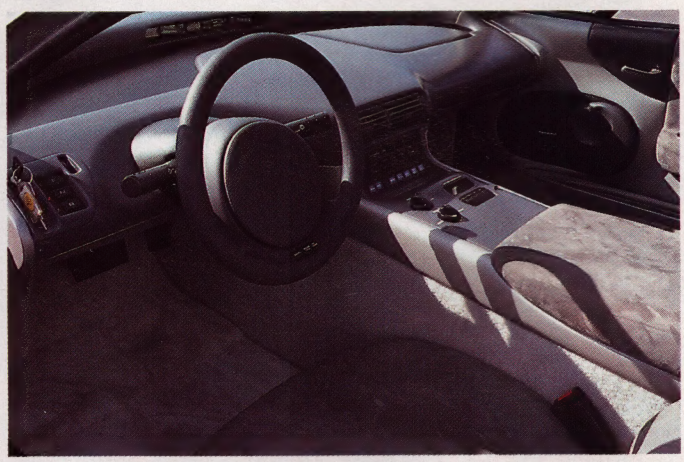
Photographs by Paul Debois





The battery-powered two-seater Impact will travel 120 silent miles on a single charge of its 32 lead-acid batteries

Impact's futuristic styling takes getting used to



Interior is modern and stylish. Instruments digital

UNTIL THE ARRIVAL of GM's Impact, electric-powered vehicles moved at milk-float speeds and had a very limited range. The sleek and aerodynamic Impact has a top speed of 100mph, will dash from standstill to 60mph in 8.0sec (faster than a VW Golf GTi), and has a range of 120 miles on a single charge.

How so? One of the primary reasons is that Impact was designed from the outset to be an electric car. Previous electric cars have tended to be based on current production models, which by the time hefty batteries were added, weighed too much to go very far or very fast.

Light weight was one of the chief goals of Impact's designers. Every component was given the diet treatment, without compromising the Impact's ability (potentially) to pass the US crash safety regulations. The body is made of composite materials, which provide the strength of steel panels at a fraction of the weight. Further savings are made because the Impact has no exhaust and doesn't require a large, multi-ratio gearbox.

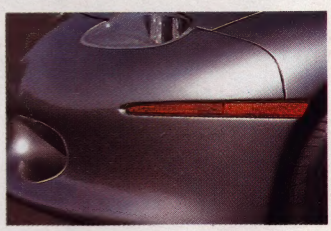
But the biggest advance the Impact has to offer is housed in a large, stainless steel box, which sits under the bonnet, in place of a normal engine. This box doesn't contain a new form of electric motor, but clever new electronics.

In the past, converting DC current from batteries to AC current to power an electric motor, involved great energy losses. The alternative was to use a DC motor, less efficient and powerful than its AC cousin. What the advanced electronics and computer software tucked away in the Impact's little silver box does, is to convert DC to AC without losing much power in the transition. The capability to do this has been around for a number of years, but not in a package as compact as this.

The batteries themselves, a pack of 32, housed in a tunnel which runs longitudinally through the centre of the cabin, are of the normal lead-acid variety. The acid inside them is in the form of a jelly, which won't run all over the cabin in the unlikely event of a battery splitting. Battery life is currently around 32,000km, though within a couple of years, GM's engineers reckon to extend that figure to 70,000km.

Charging the battery is simply a matter of plugging the car into a convenient power source. In an emergency the batteries can be charged to 90 percent of full power in an hour, but this reduces battery life considerably.

Surely, you might think, generating the electricity to charge the batteries in the first place is just an alternative way of creating more pollution. Where's the progress? GM claims that charging the batteries overnight simply uses the surplus energy generated by power stations out of peak hours. Even if the majority of the cars in London were electrically powered, there would be no need to boost electricity production.



Nose ducts cool gearbox

What's more, Impact's two electric motors (one for each of the front wheels), use their power many times more efficiently than an internal combustion engine.

And the Impact has what is known as a regenerative braking system. Release the accelerator pedal fully, and the motors become generators, as well as slowing the vehicle

down. To stop in a hurry, there are conventional brakes.

To reinforce the point that electric motoring requires little sacrifice, GM has ensured the Impact's interior is stylish and modern. It has electric windows, air-conditioning, a good quality sound system and digital instrumentation. It also has automatic transmission, operated by three buttons – forward, reverse, and neutral.

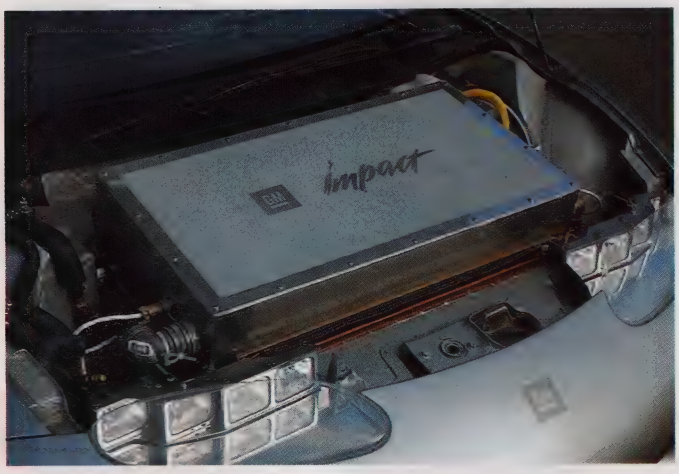
There are only a couple of aspects of the Impact which require familiarisation. The first is its Buck Rogers styling. The second is the spooky way in which it silently moves around. Neither should stand as an obstacle to its acceptance. **BF**

Re-charging takes six hours

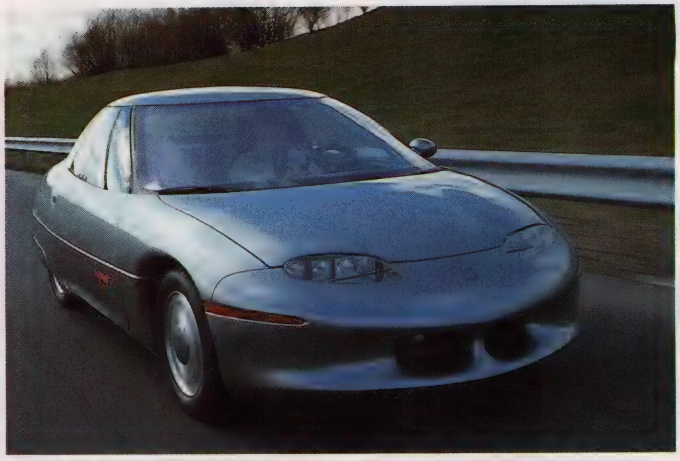
IMPACT IS NOT A dream car, unlike most concept vehicles. The sleek, battery-powered two-seater was developed with the clear aim of being put into production.

Although General Motors is still showing the original vehicle, the programme has advanced way beyond the prototype stage. At the company's design headquarters in Detroit, the styling team has already completed the second-generation Impact, which seats four and looks less futuristic. 'But whatever we do,' says Don Runkle, who is in charge of GM's advanced engineering division, 'we must not compromise on the car's three key parameters. These are the exceptional drag coefficient, the low weight and the low rolling resistance.'

While these cornerstone elements must remain intact, there is no doubt that the hardware beneath the flash body needs further improvement. First of all, GM intends to come up with a more efficient and less expensive drivetrain. The cost of the electric motors, for instance, will have to be cut in half to make the car viable to build.



Silver box houses advanced electronics, computer software



Light weight and smooth lines allow Impact to go quickly

On the battery front, progress is still painfully slow. At present, GM's AC-Delco division sees no immediately available alternative to the existing energy cells. Efforts are being made to double the life of the batteries, but little can be done about weight and mass.

Until smaller, lighter and more efficient batteries are ready for volume production, GM is working on a quick-charge system which enables the owner to restore battery capacity within one hour. At present, this process takes about six hours or overnight. If the electricity board was prepared to set up the required infrastructure in certain built-up areas, parking meters could be converted to high voltage miniature power points.

Cost is a serious problem that must be solved before Impact can go into production. At present, it still costs more to charge up the vehicle for its 100-mile driving range than to fill up a petrol-fed car to cover the same distance. But if US fuel prices were pushed up to Western European levels, and if California would make cheap solar power available, Impact owners could save money.

According to Runkle, GM will do everything it can to make Impact an affordable car. There is talk of a base price in the area of $15,000, but it is possible that the battery pack comes extra at $3000 per set.

The GM people are also talking to the federal and local governments regarding possible incentives such as tax relief, free downtown parking, free car pool use and subsidised electricity. If the outcome of these negotiations is positive, Impact may be in strong demand nationwide even before production starts. **GK**

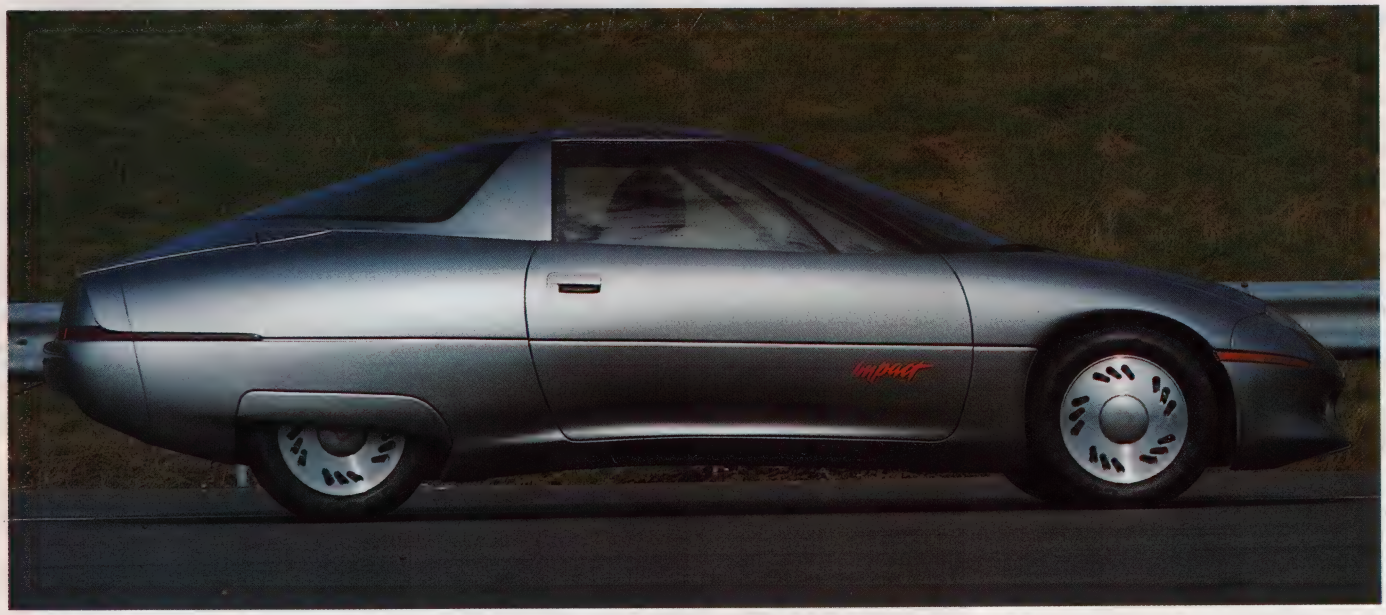


Illustration by Ian Bott

Sleek Impact has a top speed of 100mph, and is quicker than a Golf GTi to 60mph

The VW Futura uses a revolutionary engine that makes petrol power viable for another 50 years. Paul Horrell drives it

THE FUTURA IS ESSENTIALLY A greener Golf for the next century, featuring a revolutionary new petrol engine. But to get the car noticed at motor shows, the VW engineers gave it a few gimmicks. The most prominent is that the Futura can park itself. No more embarrassed reverse parks with this car: you simply get out and watch as it manoeuvres itself, guided by laser sensors, and aided by four-wheel steering, into a tight-fitting spot.

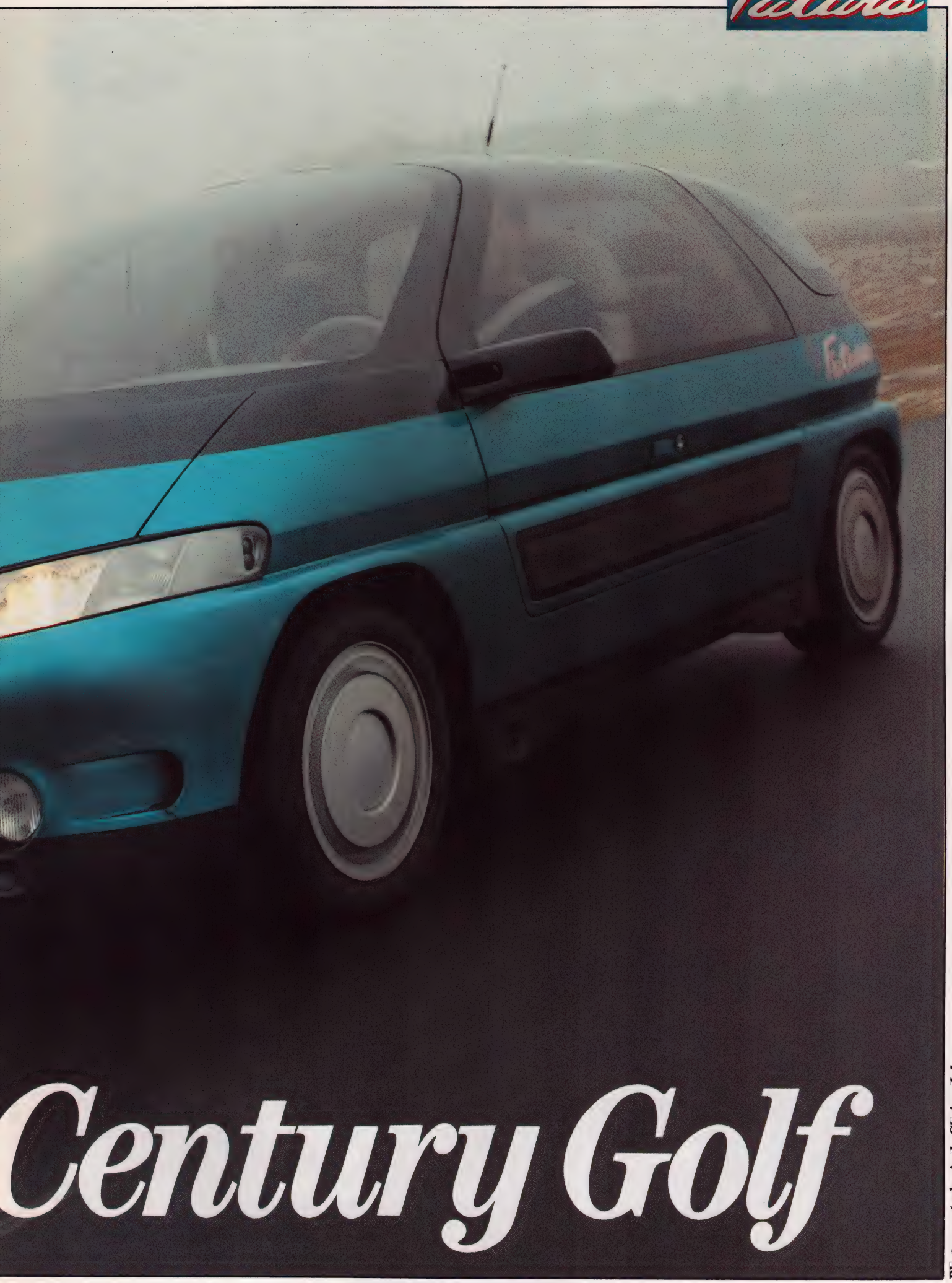
Further to make the experimental Futura stand out at a motor show, VW gave it an iridescent blue paint job, a rhubarb-and-custard leather interior, a pair of gullwing doors (that open up and out) and a glass roof and sides. But all this tinsel wrapping only detracts from the nugget inside.

The Futura's engine features direct fuel injection, as opposed to indirect injection currently used on expensive cars, or to the even less efficient carburettor. Direct fuel injection greatly reduces fuel consumption and, as a result, pollutes less. In all likelihood, petrol-powered cars built next century will use this type of engine.

Direct injection means that fuel is used far more precisely. Petrol is injected directly into the combustion chamber with the accelerator pedal modulating the fuel delivery directly. In a normal petrol engine, the accelerator alters the mass of air entering the engine, with the fuel system adding petrol to maintain the correct fuel-air ratio. That, plainly, is less efficient.

Further to help fuel economy, the Futura's engine runs very lean. To get plenty of air into the engine, an engine-driven supercharger is used. This lean mixture also reduces emissions. To meet the strictest US and European emissions standards, the Futura needs simply a single oxidisation catalytic converter – instead of


Gullwing doors open up and out

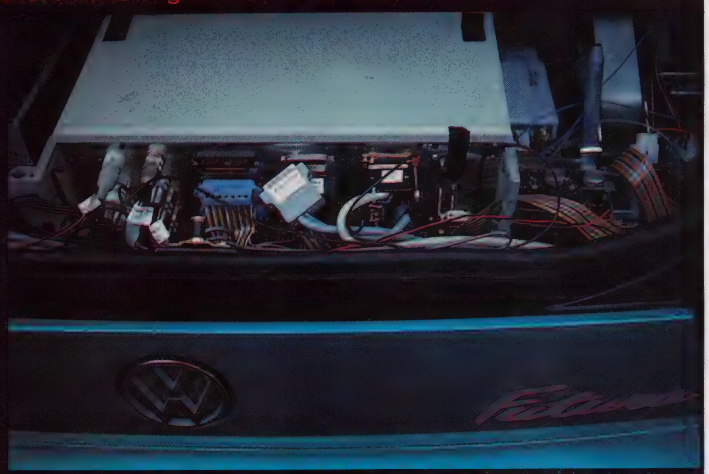


Century Golf

Photographs by Andy Christodolo

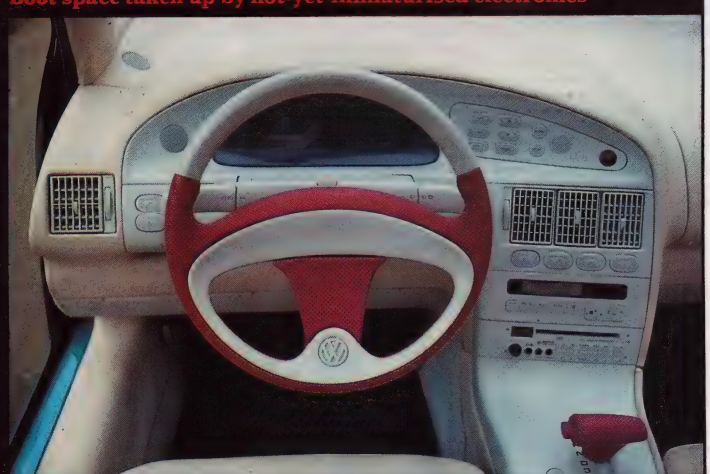
The first thing that strikes you when you engage drive in the iridescent and overweight Futura is the vehicle's sloth

Futura attracted much attention as it emerged from transporter

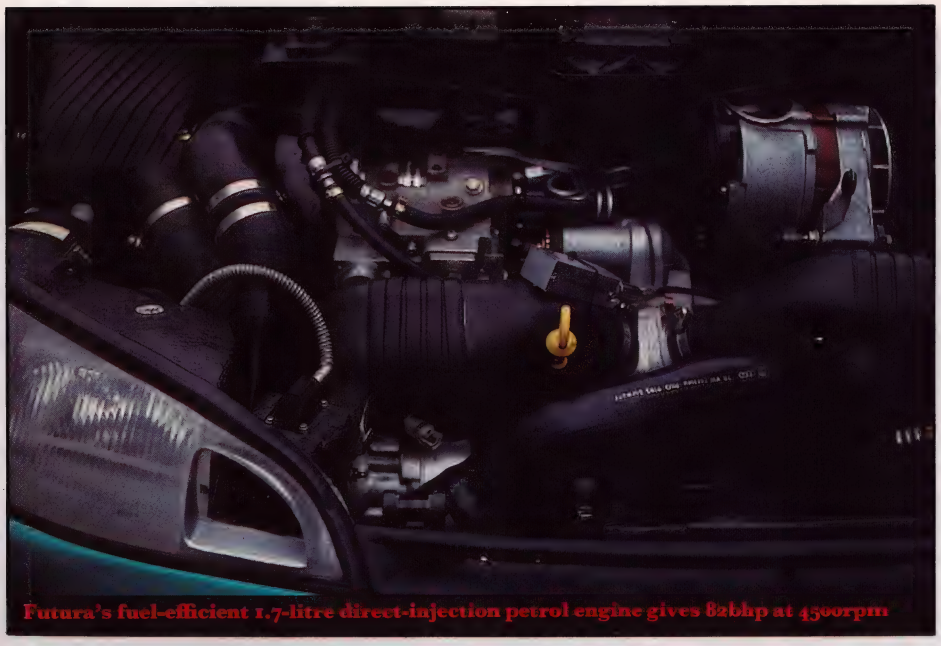


Boot space taken up by not-yet-miniaturised electronics

Interior is distinctive, trimmed in rhubarb-and-custard leather



There are no instruments – just an all-electronic display



Futura's fuel-efficient 1.7-litre direct-injection petrol engine gives 82bhp at 4500rpm

the more expensive (and complex) three-way catalytic converters modern cars need.

In many ways, Futura apes some of the features of a diesel engine. Its direct-injection system is similar to a diesel's, and this helps it approach the fuel efficiency of a diesel (a diesel, typically, is about 30 percent more economical than an equivalent petrol unit).

As with a diesel, the Futura runs a very high compression ratio: 16.0 to one, compared with the normal 10.0 to one or so, typical of conventional petrol cars. High compression ratios promote efficient combustion, but they're impossible in a normal petrol engine: the heat of the high compression ignites the fuel/air mixture in the cylinder before it's ready to ignite (petrol is far more flammable than diesel, and thus easier to ignite). In the Futura, the direct injection delivers the fuel at the time it's due to ignite, and then the spark initiates a controlled, smooth burn. That, in a nutshell, is the key advantage of direct injection.

So why haven't we seen it before? It's mainly to do with the difficulty of making a pump that can deliver petrol at the necessary high pressure. Diesel fuel is oily and so lubricates its pump; petrol isn't and doesn't. Now Stanadyne, an American company, has developed (at least to prototype stage) a pump that has ceramic moving parts which don't need lubrication. There are other problems: the high temperatures and pressures in the combustion chamber are extremely hard on spark plugs. VW has new, three-electrode plugs, but even these don't last long.

The result of all this is a 1.7-litre engine of a respectable 82bhp at 4500rpm, but giving urban fuel savings over a standard petrol engine of about a third. To save more fuel, the Futura has a novel engine-cooling system, which works by allowing a small volume of water to be gradually turned to steam as it works its way by convection up through the engine. A radiator condenses the water, which a small pump returns to the block. This design uses far less water than a normal system, so warm-up is quicker, and the smaller pump means much lower pumping losses. There's no radiator fan, either. All in all, the cooling system gives a five percent fuel saving.

The Futura is also designed around a new window glass that passes light perpendicular to itself, but not at acute angles – cutting solar heat in the cabin by a claimed 60 percent, and making lower demands on the power-sapping air-conditioning.

It wasn't just to gather attention at motor shows that VW gave the Futura a one-box shape. It's space-efficient, it's aerodynamic and for pedestrians it's more comfortable to be run over by. But, as the car rolls slowly out of its plain white transporter, its ability to draw a crowd is proved first. An anxious-looking Wolfsburg engineer takes the first turn. Starting up and idling, the Futura sounds more diesel than petrol, most like a multi-cylinder turbodiesel, but softer.

The car's doors are split horizontally, the upper being the gullwing and the lower dropping into the sill. It's no great feat to get in. Doors shut easily and the view out is good. If you feel like it, you can remove the wraparound rear glass hatch and the gullwings, for a cabiolet effect.

There are no instruments, just an all-electronic display; a digital speedo, and another display that advises you whether or not your speed accords with what the car's computer reckons is reasonable for the traffic conditions sensed by the on-board lasers. More useful, a laser measures the distance to the car in front, and warns the driver if he's too close. Another display is prepared for electronic navigation.

To allow the automatic parking to work, the Futura's gearbox is the four-speed auto from the Passat. Once you engage drive, the most striking thing is the car's sloth rather than any engine characteristic. This car has electrically powered seats, a heavyweight, experimental, steering rear axle and a bootful of unminiaturised electronics. It's vastly overweight. But the engine is perfectly agreeable, smooth and responsive.

We return to Wolfsburg in a Golf powered by the same type of direct-injection engine. It does without the evaporative cooling, but it shows what the Futura's engine could do in a car of sensible weight – it's acceptably brisk and far quieter than a diesel. The engine isn't meant to bestow a huge advance in driving fun; the pleasure is in being green without making the sacrifice.

Futura's most prominent gimmick is its ability to park itself. To the complete amazement of passers-by, it can manoeuvre into the tightest of spots, guided by laser sensors and helped by the four-wheel steering system

IF IT HAS TWO ENGINES, W

It really doesn't matter where you look. You'll come away convinced the new Senator CD has just one engine.

A 3.0 litre, 24 valve power plant in the usual place, under the bonnet.

Few people guess the truth. That what seems to be a traditional straight six is in fact two engines in one.

The transformation takes place at 4000 revs.

Below this a valve closes, dividing the airflow to the engine so that it runs as two separate three cylinder units.

Then, once the revs increase above 4000, the valve opens to link all six air intakes and turn the separate units back into a straight six engine.

The reason for this double act becomes obvious the minute you set off.

A touch of the throttle delivers the power. Instead of building slowly, it's available at all speeds and in each gear.

This well-mannered verve lets you top 60 mph in 8.8 seconds without a murmur of complaint from the engine.

HERE'S THE OTHER ONE?

The handling is equally effortless.

A new 5-link rear suspension system stabilizes the car, helping you to stay in control even in an emergency.

Having made such strides with the engine and suspension, we added further touches of refinement inside and out.

There's more wood and leather on the restyled centre console.

We've fitted a compact disc player and protected it with a new security system.

The boot now boasts a spoiler.

And below that, the rear lights are even smarter than before.

You'll be able to spot the changes quite easily. Which is more than can be said for the other engine.

SENATOR CD
24 VALVE

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WHAT THE EXPERTS SAY

LINDSEY HALSTEAD

Chairman
FORD OF EUROPE

IF YOU'RE CONFUSED BY THE multitude of car models on sale today, then Ford's European chairman Lindsey Halstead has got bad news for you. Things are going to get worse.

'I'd like to be able to tell you that there will be a typical type of family car on sale in 15 years,' says Halstead, Ford's European chief for the past 18 months. 'But things just aren't going to be that simple. They are going to get more and more complicated. Not only will there be a bigger range of models than ever, but there will be different types of power units, using different types of fuel.'

According to Halstead, Ford should be selling two-stroke cars, electric cars and cars running on more than one type of fuel, by the middle of the next decade. But cleaned-up petrol engine, predicts Halstead, will power the majority of cars in 15 years.

'There will also be a bigger range of models. As people become more affluent, they will want more. The big manufacturers will have to be more flexible, and offer a greater range of body styles: such as two-door convertibles, minivans and off-roaders, as well as the conventional family cars and estates. As there will be more cars on the road, people will want more individuality.'

The environment, says Halstead, will be the most important issue of the future: 'The current environmental concern is not a passing fad; I'm sure of that. Instead, people will become more and more environmentally aware. And we, as a manufacturer of consumer products, have to give the consumer what he wants. We have to be more environmentally responsive. And yet we also have to take into account the increasing affluence of consumers.

'People are most certainly not prepared to give up the freedom that a private car offers. But they are prepared for certain constraints. They are also willing to pay more for a "green" engine than a "brown" one.'

The pollution-free car, says Halstead, is still 'many, many years away'. He mentions electric cars, charged from on-board solar cells, and hydrogen-powered cars as 'possible for the middle of the 21st century'. For now there are 'partial' solutions.

'We have been doing a lot of work on the two-stroke petrol engine, which offers a number of advantages compared with the current four-stroke petrol motor. It's a smaller engine, so the car powered by it can be smaller and lighter. It is less thirsty, and is better on emissions. We're intending to fit such an engine to a new small car, smaller than the current Fiesta. Low fuel consumption would be one of its key selling features. We haven't got a launch date for this car yet, but it is likely to be in the next 15 years.'

'People are not prepared to give up the freedom of cars'

The electric vehicle has a future as a city runabout, but its problems – high cost, low range, low performance – rule it out as a general replacement for petrol-powered cars: 'Besides, you have to charge electric cars from power stations, thus replacing one form of pollution with another. Really, there needs to be a big breakthrough in battery technology, before the electric vehicle can be seen as the car of the future.'

More likely, in the short term, are what Ford calls 'flexible fuel' vehicles. These cars, using conventional internal combustion engines, can use a fuel source in addition to petrol. Likely alternatives to petrol are methane (or natural gas), liquefied petroleum gas, methanol or ethanol.

An American, Halstead has much experience in alternative fuels: he is the former president of Ford of Brazil, the first country to invest heavily in a car fuel other than petrol. To make its country as self-sufficient as possible, the Brazilian government decided to reduce oil imports by brewing most of its fuel from sugar cane. The ethanol that was produced was three to four times more expensive than conventional petrol, and gave far worse fuel consumption.

At its peak, in the mid '80s, ethanol was used by 95 percent of Brazilian cars. Now the figure is down to 50 percent, and continues to drop. The plain fact is that petrol is cheaper to produce.

'The cars in Brazil run perfectly satisfactorily on ethanol,' notes Halstead. But, for Europe and the US, methanol is more promising. Ford, in concert with the US oil company Sunoco, is now undertaking a major study in America on its benefits. Methanol – which is cleaner-burning than petrol – is likely to appear, in volume, in some American states – notably California, where pollution controls are traditionally the world's strictest – before the end of this decade.

As with ethanol, methanol has less energy content than petrol, and suffers from poorer fuel economy: Ford tests have shown that 1.7 gallons of an 85 percent methanol/15 percent unleaded petrol mix are needed for every gallon of unleaded. Adds Halstead: 'Despite the attractions of these fuels, petrol-powered vehicles, complete with all the emissions equipment necessary for them to pass pollution regulations, are likely to be more cost-effective for many years to come.'

Two-strokes, electric cars, hybrid vehicles, and methanol-powered engines should all mean less pollution per vehicle. But, with Ford cheerfully forecasting that West European car sales will boom from about 13 million a year now, to more than 14 million by the end of the '90s, and with East European sales likely to treble in the next 10 years, there will be *more* cars. And more cars means more pollution, right?

'Wrong,' says the Ford chief. 'The big improvements in emissions controls, plus the reduced fuel consumption of these new-generation cars, will mean than the total pollutants will be less.'

Environmental pressures have, predictably, forced Ford greatly to increase its expenditure on reducing

Photograph by Mervyn Franklyn

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emissions and cutting fuel consumption. But challenge Halstead on why Ford, or for that matter any other car maker, didn't better anticipate the trend, or show more environmental concern *before* the issue became trendy, and the chairman doesn't proffer any excuses.

'We are a consumer product company. We react to consumer demands. Not that long ago, fuel consumption was not such a big issue. Now it, and the environmental question, is. I will admit that we, as an industry, misjudged the speed of environmental demands and change. I wish we'd done more 10 years ago, so we could offer more fuel efficient, lower-polluting vehicles now.'

There will be more progress made in the next 10 to 15 years, in car development, than we've ever seen before. Halstead envisages not just changes in engines, but the way in which vehicles are used: 'People will spend more time in their cars, probably partly because of the traffic. Consequently we will fit car phones, computers and fax machines as an integral part of the car.

'And, in about 15 years, I reckon you'll see the first "auto pilots", where you'll get your car onto a highway, and it will be electronically guided and driven. You can sit back and have a sleep, or do some work. Such technology is possible now. After all, it's common in aeroplanes. We just have to succeed in getting the costs down.' **Gavin Green**

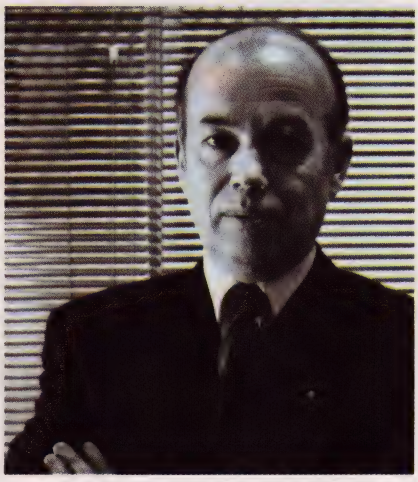
ULRICH SEIFFERT

Director of R and D
VOLKSWAGEN

THE INTERNAL COMBUSTION engine will continue to be the major car powerplant of the next century, according to the head of research and development at Germany's biggest car company, Volkswagen. But, says Professor Ulrich Seiffert, the engine will undergo drastic changes.

In America, Seiffert predicts that next century many Americans will be filling their cars with methanol, not petrol: 'Methanol, manufactured from natural gas, has great promise,' says Seiffert. 'It is cleaner-burning than petrol, and conventional engines can run on it very easily. But in Europe, I think that petrol will be the major fuel for many years to come – maybe until about 2040.'

The internal combustion engine, using either methanol or petrol, will change comprehensively, however. By the year 2000, Seiffert predicts that the direct injection petrol unit will be available – offering major fuel economy benefits.



'The Hybrid will be very popular with town drivers'

Such a unit is currently being tested, by Volkswagen, in its Futura car-of-the-future proposal (see road test on page 10). The direct-injection petrol engine promises the fuel efficiency of the diesel engine, but with the smoothness and cleaner-burning qualities of the petrol unit: 'As with the current petrol engine, it could run on methanol, or other alternative fuels – such as ethanol.'

Methanol, which Seiffert says may be widely available in California before the end of the '90s, still produces carbon dioxide – the gas thought to be the major contributor to global warming, or the 'greenhouse' effect – when burned: 'But much of the natural gas from which methanol can be manufactured is burned off now – producing absolutely no energy, but producing carbon dioxide. A similar thing happens to petroleum gas burnt off at refineries, from which methanol can also be produced. Converting it into methanol means it is being used more efficiently.'

Apart from methanol, Seiffert foresees other alternative fuel sources, or engines, being developed in the next decade: 'The hybrid vehicle has a big future. This may be a vehicle using either a combination of diesel and electric power, or one using both petrol and electric power. Most of our research has been on the diesel/electric (see the Hybrid road test, on page 38). The electric engine is used when low power outputs are adequate – such as in town. In the country, when you need more power, the vehicle automatically uses the diesel engine.'

Volkswagen's own diesel/electric Hybrid will go on sale in three years, says Seiffert. It will cost the same as a top-of-the range Golf GTi (about £14,000 of today's money). He expects it to be bought, initially, by governments keen to propagate a 'green' image, and by certain companies: 'Late in the '90s, or early next century, I think the Hybrid will be popular with private motorists, who do a lot of town driving.'

Electric cars, says Seiffert, will find favour – in the next decade – with government departments and with companies performing in-town deliveries: 'I do see private motorists buying electric cars within the next 10 years – but very much as second cars. You would need a petrol or methanol vehicle to go on holidays, or to go away for the weekend. But much work still needs to be done on electric cars. The battery technology is still not good enough. And if you run out of charge accidentally, you are absolutely stranded. You can't just put some more fuel in the car, and continue on your way.

'And where do you get the power from? If you are using coal or oil-fired power plants, it is a very inefficient way of getting power. On a country road, a diesel car produces less carbon dioxide than an electric car charged from a coal-fired power station.'

Volkswagen, along with Mercedes-Benz, BMW and the French car makers, is still investing huge sums in diesel research. The greater fuel efficiency of the diesel engine, compared with petrol power, gives it an immediate advantage in producing less carbon dioxide. Seiffert's team is currently working on a diesel that automatically switches itself off when the vehicle is stationary, or decelerating. The Lower Saxony police are now running development cars, so powered: 'Tests have shown that the fuel consumption is reduced by 20 percent.'

The future of the diesel depends on its cleanliness. Its lower fuel consumption is appealing, but set against that are the diesel's output of particulates – bits of soot, that are allegedly carcinogenic – and its comparatively high output of oxides of nitrogen: 'If we are successful with our diesel research, we think about 20 percent of all Volkswagen-Audi cars by the year 2000 will be diesel-powered, compared with 16 percent now.'

Long term – beyond 2010 – Seiffert sees more electric vehicles and, perhaps, hydrogen-powered cars: 'Hydrogen is an ideal fuel source, because it's so clean. But there are big problems. How do you

Photographs by Paul Debois

WHAT THE EXPERTS SAY

store it safely in a vehicle? And how do you produce it inexpensively?'

Short-term, the main goal must be to reduce fuel consumption: 'By how much we reduce consumption depends on government legislation, customers' preferences, and on the price of fuel. We could reduce the average fuel consumption of our fleet of vehicles by two percent a year, if we had to. More likely, the average car in 10 years is likely to be about 10 percent more economical. But it depends on so many things. Ten years ago, we launched our Formel E range of cars, at a time when we thought people wanted more fuel-efficient cars owing to the oil crisis. But those cars, which were very economical, were not popular. Instead, fuel consumption stopped being important. I doubt whether fuel consumption will cease to be an important issue in the future, but who knows for sure?'

Better integration of private and public transportation is crucial: 'After 2000, I can see people driving their cars to big car parks on the outskirts of cities, and jumping aboard people-carrier rail systems, going to five or six different locations within the city. Once there, the people may use conventional public transport systems.'

Seiffert reckons cars are likely to be used less in the next century, even though there are likely to be more of them: 'Most cars probably will not be used as everyday transport. Public transport will be used more in that role. Instead, cars will be more for recreation and leisure; they will become more fun. As a result, they will become more specialised. Common platforms would still be used, but we would be able to fit different bodies, and give the cars a different, more specialised purpose. There are likely to be little fuel-efficient two-seaters for city driving and shopping; roomy seven-seater vans for taking the family on holiday; pretty open-top two-seaters for young people to enjoy; rugged cross-country vehicles for hunting and fishing; and more.'

If the overall fuel consumption of road transport is to be reduced, it is also crucial to take more trucks off the road, and send more goods by train, says Seiffert. If this happens, and the fuel efficiency of cars is greatly improved, Seiffert reckons it will be possible to cut the total world carbon dioxide output of road transport by half, early next century: 'But to do this, it is absolutely essential to give the developing countries access to the very latest technology. It is useless for Europe and the USA to cut consumption, if Asia and Africa increase their consumption by the same amount.' **GG**

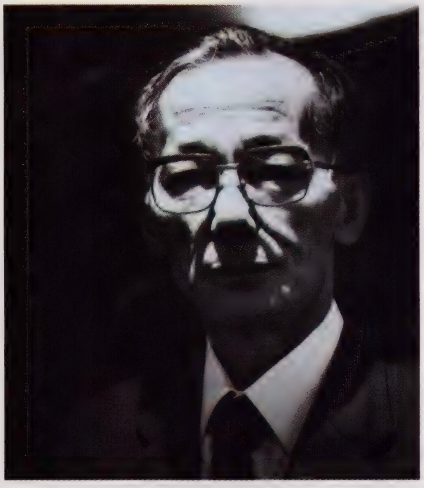
SHIRO SASAKI

Executive vice-president
TOYOTA

DON'T EXPECT A MOTORING revolution in the next 10 to 20 years. European motoring bosses may be making bold noises about electric cars and dual-engine 'hybrid' vehicles, and prophesying faster change than ever before. But, according to Toyota, Japan's biggest car maker, 'you'll see the same degree of change in the next two decades, as you've seen in the past two'.

Mind you, 'the same degree of change' for a Japanese manufacturer would constitute a revolution for any European maker. In the past 20 years, Japanese cars have gone from being gimmicky, crude and frangible, into the technical equal of Europe's best. Twenty more years at this pace, and Europe's car industry would probably lie in tatters.

'Compact two-strokes will bring great all-round benefits'



Yet Shiro Sasaki, Toyota's executive vice-president responsible for research and development, does not foresee Japanese makers pulling far ahead of European and American manufacturers next century: 'In some areas, I think we are technically superior to the Europeans; in some ways still technically inferior. I think this relative balance will continue into the next century.'

Petrol and diesel will continue to be the most widely used fuels of the next two decades, says Sasaki: 'Methanol has a good future, but only in certain markets. It burns cleaner, so it offers emissions advantages. But when you consider the whole methanol production process – and it takes more energy to manufacture than does refining petrol – the overall energy and emissions benefit is negligible.'

In order to reduce fuel consumption, and cut carbon dioxide emissions, Sasaki sees more 'lean burn' engines (increasing the ratio of air to petrol, during the combustion process). This is difficult to achieve when a car uses a three-way catalytic converter – compulsory in many countries, and about to be mandatory on many cars throughout Europe. Three-way catalytic converters demand precise ratios of air to fuel, with no excess, thus cars using catalytic converters cannot run 'lean burn'. Sasaki is coy on how Toyota may overcome this problem but the answer, obviously, is to produce an engine that can pass emissions laws without the need to fit a three-way cat. Direct-injection engines (see VW Futura test, page 10) undoubtedly figure in Toyota's research.

Toyota is also a keen proponent of the two-stroke engine: 'Its compact size would mean tremendous all-round benefits. It means the vehicle can be smaller and much lighter, greatly helping fuel economy. But there are emissions hurdles to clear.'

Cleaner than the two-stroke, but thirstier, is the gas-turbine motor, which Toyota is developing enthusiastically. The gas-turbine engine can meet all current emissions legislation – without the need for a catalytic converter. It is also super-smooth, does not require a bulky radiator (or other means of liquid cooling), is fuel-efficient when run at a constant speed, and can use a multitude of fuels – kerosene, petrol, methanol, diesel, ethanol, and more. Its drawbacks include its thirst in stop-go driving (20-30 percent thirstier around town than a petrol engine, according to Toyota's research), its noise (rather like that of a jet engine's), and its 'lag' when trying to accelerate. Toyota is confident it can overcome these problems.

The gas turbine, says Sasaki, 'is more than 15 years away'. I see it as a possible stage in between the current petrol internal combustion engine and a new engine of the future, that uses natural power and does not pollute.'

And what sort of engine would that be? 'Who knows. If I had to guess, I'd say it would rely on solar power, but how it will be harnessed and utilised is very difficult to day.' **GG**

WHAT THE EXPERTS SAY

Same story...

…different ending.

The new Scorpio saloon.

Ford

POWER HYDR

This ordinary BMW runs on the fuel of the future. Roger Bell tries it

THE ENGINE OF THE BMW 735i fired first time and settled into a lumpy tickover: 'It's running weak,' said research engineer Wolfgang Strobl, explaining the roughness. When he blipped the throttle, white vapour gushed from the tailpipe. 'Bend down and get your nose in it,' he urged. I did, and smelt nothing. Harmless steam washed over me. As engine temperature increased, so the vapour subsided; on a warm day, it would be invisible.

Flicking a dash switch, Strobl called out again: 'Now smell it,' he demanded. The stench of noxious fumes assailed my lungs as clean-burning hydrogen gave way on this dual-fuel car to petrol.

We were in Munich, at an offshoot of BMW's headquarters, to try the world's only street-legal hydrogen-powered car. 'We need special permission from the authorities to drive it on public roads,' explained Strobl, who heads BMW's hydrogen-car research project.

Hydrogen is potent stuff. According to Peugeot, one liquid cubic centimeter of it packs the explosive punch of two kilograms of TNT. The great Hindenburg airship was destroyed in a fireball of hydrogen, and space rockets are blasted to the moon by it. Little wonder, then, that the public perception of hydrogen is one of a dangerous high explosive unsuited for use in cars.

It *is* unsuitable, but not primarily

Photographs by Martyn Goddard

RED BY OGEN

● **Front of BMW's boot houses 20.5gal hydrogen tank, good for 150 miles**

because it is dangerous. BMW believes that when the oil runs out or becomes too expensive to extract, perhaps in 50 years' time, hydrogen could be the fuel to replace it. For a start, it is inexhaustible. Two-thirds of the globe's surface is covered by the substance that is two parts hydrogen to one of oxygen: water. As every third-form drop-out knows, when an electrical current is passed through water, H_2O, electrolysis breaks it down into hydrogen and oxygen. Burn one in the other, and water is reformed. 'The only resource you need to produce hydrogen is primary electrical energy,' says Strobl, looking up at the sun.

Environmentally, hydrogen is the perfect fuel for road vehicles as it creates neither noxious pollutants nor carbon dioxide, cause of the greenhouse effect and alleged global warming. That it can be harnessed for use in a conventional internal combustion engine is not in dispute; after a decade's development, BMW's hydrogen-powered 735 runs much like any more conventional car.

The snag is that hydrogen is nightmarishly tricky to handle – and at the moment prohibitively expensive to make as an everyday fuel. Its production, distribution, storage and transfer present huge and costly problems that are decades away from solution on a global scale. A totally new infrastructure, politically motivated (and far beyond the scope of BMW's research) would be needed before hydrogen could be used widely instead of fossil-based fuel.

Hydrogen is light and flimsy and cannot be carried in gaseous form as the volumes would be colossal. Even when compressed to 20 atmospheres (the pressure at which it is commercially available in cylinders) its tankful range would still be unacceptably short. Nor does any known metal nitride, which soaks up hydrogen like a sponge, release enough of the gas when heated to feed a hungry engine. It can be used only in liquid form – and that's the problem.

Hydrogen does not liquify until its temperature is lowered to a staggering —253 degrees centigrade. Imagine refuelling with a liquid that's close to absolute zero: 'Robot couplings will be the only way,' predicts Strobl.

BMW chose a long-wheelbase 735i as its latest hydrogen-powered testbed because of its roominess. Inside, the rear seats have been moved forwards to make space at the front of the boot for a 20.5-gallon cylindrical tank, good for 150 miles, that is out of harm's way in the event of a tail shunt. The normal petrol tank and fuel system is retained.

The pressurised tank (it can be made from various materials) is like a giant Thermos flask, the vacuum between its two skins fitted with 70 layers of aluminium foil and glassfibre to give insulation that a polar bear would envy. The refuel plumbing (it takes skilled technicians an hour to replenish the tank) and engine feed pipes are equally well protected and insulated, to prevent the highly volatile liquid hydrogen from evaporating. Even so, two percent of the tank's contents are lost to the

'One liquid cubic centimetre of hydrogen packs the explosive punch of 2kg of TNT'

POWE
HYDR

atmosphere every day.

Hydrogen gas can be drawn direct from the tank, regulating its internal pressure, but fuel is normally forced forwards as a liquid. After warming in a heat exchanger, hydrogen gas passes through what BMW calls a dosing valve (a regulator) before being fed at around ambient temperature through special nozzles into the intake manifolds. Here it is blended with excess air to make the mixture very weak, or lean burn.

The weak gas/air mixture helps eliminate small traces of nitric oxide emissions but also reduces power – down, anyway, compared with petrol (one litre of petrol has the same energy efficiency as three litres of liquid hydrogen). To offset this problem, additional air (and thus oxygen) is pumped into the engine by a centrifugal supercharger driven by a variable-ratio belt to keep it spinning at around 80,000rpm, regardless of engine speed. A magnetic clutch disengages the supercharger when running on petrol.

Output on hydrogen is lower than with petrol: 'We get about 135bhp from the supercharged hydrogen engine, compared with 200bhp unsupercharged on petrol,' says Strobl. Switch over when accelerating and you can feel the car surge forward with extra vigour as hydrogen gives way to petroleum – fed to the engine by a normal injection system.

Performance apart – the 735i has a top speed of 112mph on hydrogen – you cannot detect subjectively which fuel the car is running on. Herr Strobl explained that extra noise and loss of refinement on both fuels was down to the experimental nature of the installation.

If sensors detect even tiny concentrations of hydrogen gas, the windows and sunroof are automatically opened to release it: 'Hydrogen is most dangerous in confined spaces, like natural gas,' explains Strobl. 'Outside, in free atmosphere, it is not as dangerous as petrol.' Despite its low flashpoint BMW asserts that the risk is 'probably no greater than with conventional sources of

● **Research engineer Wolfgang Strobl**

● **Refuelling is a skilled job**

'When oil runs out or becomes too expensive to extract, hydrogen may well replace it'

● **When riding in the BMW, you can't tell which fuel it's running on**

● **No air must get into the tank; double-skinned pipes make sure it doesn't**

RED BY OGEN

energy, provided the fuel and tank are handled properly and precautions are taken in the design of the vehicle.'

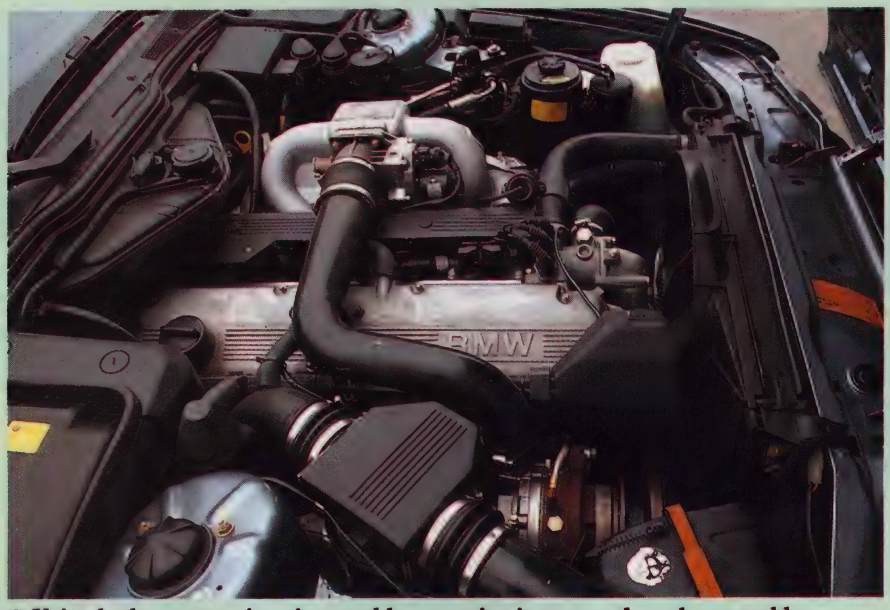
Although liquid hydrogen would cause severe frostbite, it evaporates so quickly at normal temperatures that there is little danger of making contact with the stuff, or of it forming into dangerous puddles, as petrol might if spilt in an accident.

In the next century or so, the world's electrical energy will come from many different sources – coal, oil, nuclear, wind, wave, hydro, geo-thermal: 'We shall need them all,' insists Strobl. In the long term, though, BMW is pinning its faith on solar energy as the key to clean and endless electricity that will eventually power all our vehicles – either directly by electric motors, or indirectly through engines run on hydrogen produced from the electrolysis of water.

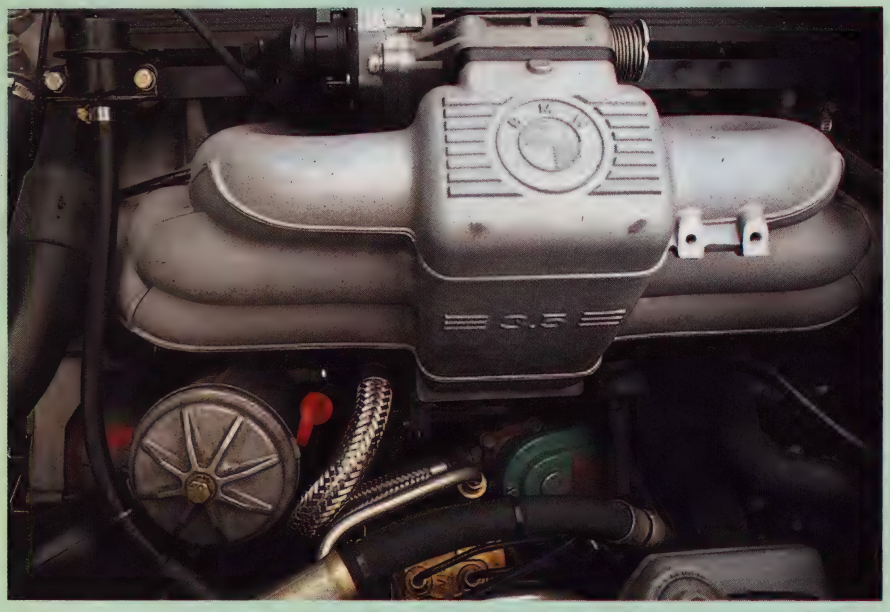
'Electric cars are more efficient,' says Strobl, though he concedes that failing a breakthrough in battery technology, they will remain urban runabouts because of poor performance, short range and lengthy re-charging. Hydrogen-powered cars that do not suffer from these drawbacks would be the long-distance expresses of the distant future.

BMW is one of several industrial German giants to have a stake in SWB – Solar Wasserstoff Bayen GmbH (Wasserstoff is German for hydrogen) – which is building a pilot hydrogen-producing plant based on solar energy at Neuenburg. BMW also has the world's only hydrogen-engine test cell, where work continues on raising power output, reducing fuel consumption, cutting costs, and minimising NO_x emissions.

Hydrogen power is not just around the corner, though Strobl talks of possible medium-term pilot schemes in critically polluted areas, perhaps using dual-fuel cars. In its two related research programmes – one into electric cars, the other into hydrogen fuel – BMW is looking 100 years ahead. Or is it 50, even 30? No-one is quite sure.



● **Using hydrogen, engine gives 135bhp; running it on petrol produces 200bhp**



● **Extra plumbing converts liquid hydrogen to gas before feeding it to manifold**

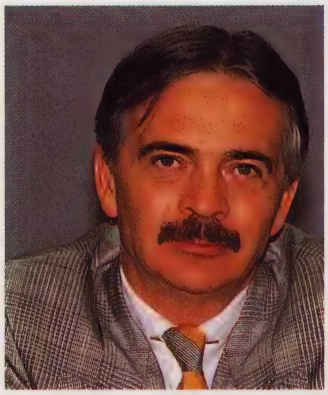
● **Dash switch alters fuel used**

● **Dirty? No, it's harmless steam**

'Liquid hydrogen evaporates so quickly, it won't form dangerous puddles like spilt petrol'

RENAULT

PATRICK LE QUEMENT

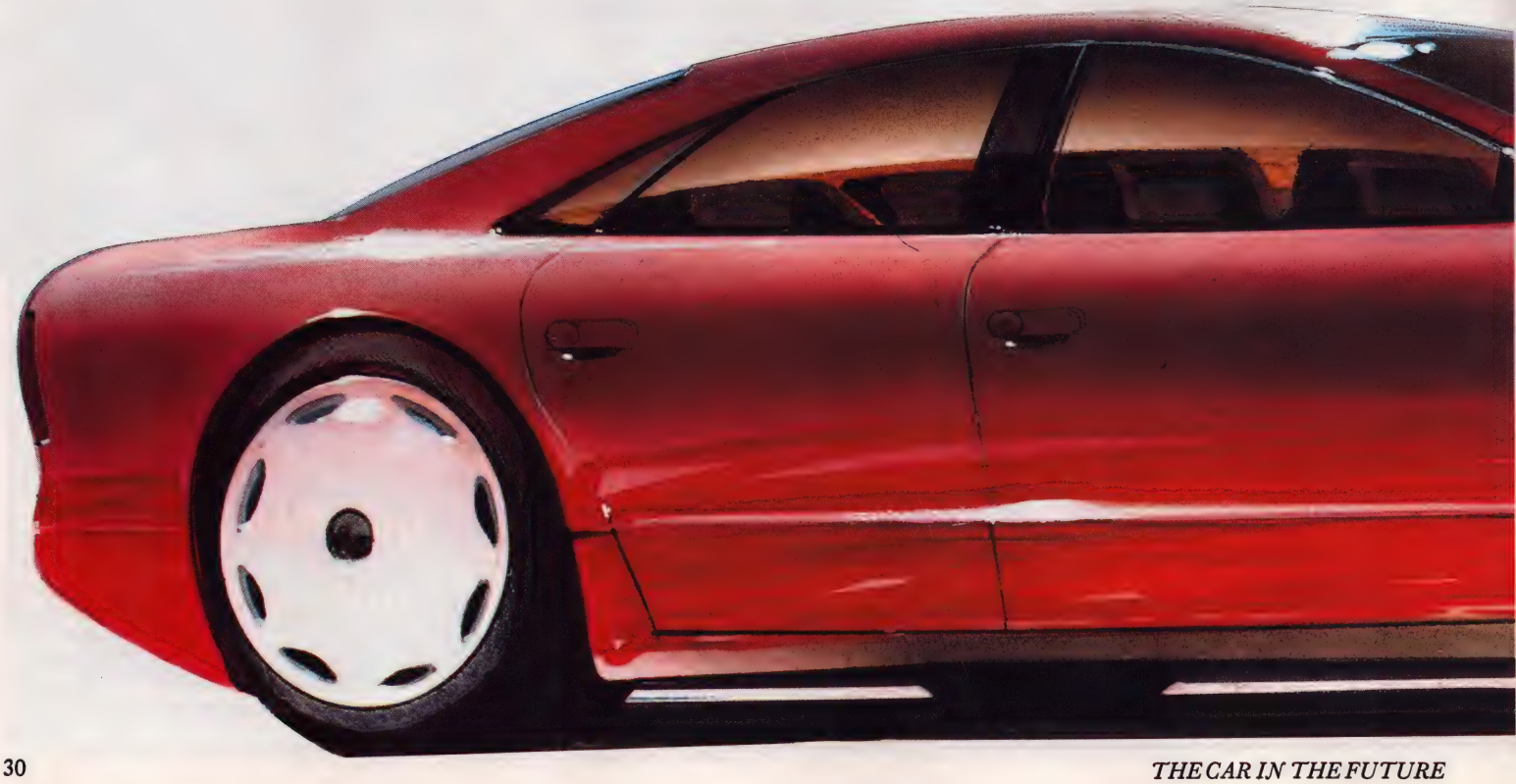


Born: *1945*
Previous employers: *Simca, Ford, VW*
Chef d'oeuvre: *Ford Cargo truck*
Characteristic strength: *has more ideas than a volume car maker can put into production*
Dream car: *Ferrari 250GT Lusso*
Favourite colour: *a very cool blue with a dash of purple*
Hobbies: *painting*

Future concepts: 'The synthesis of form and function still holds plenty of undiscovered facets. Among them the minivan and inexpensive sports car.'
Exterior design: 'The lookalike world car in my view has no future. The people are much more interested in tailor-made shapes which reflect the customer's individuality. New cars must be chic *and* practical.'
Interior design: 'Here we have plenty of room for innovation. I'm sick and tired of these awful cabins in light black and dark black. We are therefore experimenting with new colour schemes and avant-garde materials. How about a combination of dark green hide and transparent kevlar?'
Company styling traits: 'With the exception of the corporate Renault rhomb, there are practically no limitations. On the contrary: I don't believe in the so-called family face. When the baseline model has the same front-end treatment as the flagship, the overtaking prestige and the image of the marque suffer.

This is a sports car unlike any other. It's a street-legal Paris-Dakar racer, which beats the rush-hour traffic by going off-road if necessary: 'I did a fun car for people with petrol in their veins,' says le Quement. 'I was not really interested in the power output of the engine or in the drag figure. What counted were driving pleasure and engineering excellence. You see, the motor car is meant to be a perfect tool. In this particular case, the vehicle excels as soon as the going gets really tough.'

The raison d'etre of this radical two-seater becomes obvious at first sight. There is plenty of ground clearance to ensure excellent off-roadability, there are big tyres for optimum traction, and mid-engined lay-out for perfect handling and roadholding.



Designer Briefs

Georg Kacher asks five leading car design chiefs to draw up their personal dream car

AUDI

HARTMUT WARKUSS

Born: *1940*
Previous employers: *Mercedes, Ford*
Chef d'oeuvre: *Audi 80 Mk1*
Characteristic strength: *shaped the cars that marked Audi's turnaround from a volume to a prestige manufacturer*
Dream car: *Jaguar XJ12*
Favourite colour: *blue*
Hobby: *gliding*

Future concepts: 'I believe in the evolution of recreational vehicles such as minivans and estate cars.'
Exterior design: 'We'll continue to see smooth and flowing lines, but the cars of tomorrow won't be quite so round any more, and the windows will be more upright. Chrome and bright colours will soon be back in fashion.'
Interior design: 'Cosiness is very important. To achieve it, you can apply friendly materials as well as safety-related items such as seats with an integrated belt system. We are also looking at affordable air-conditioning units for smaller cars and at electronic features such as a memory function for seats, steering wheel, mirrors, radio and cabin temperature.'
Company styling traits: 'For Audi, these are the four rings, a dark grille framed by a set of rectangular headlamps, slim C-posts and a third side window.'

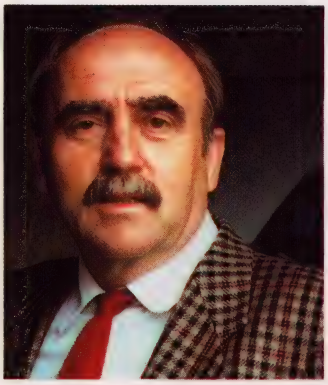
Warkuss's personal dream car is a prestigious full-size saloon. Why? Because Audi wants to be the pike in the fish pond, where the big players have Mercedes and BMW written all over their shiny scales.

But Warkuss is not interested in conservative proportions, or in chrome as a key styling feature. He wants to pack the state-of-the-art engineering in a subtle but elegant wrapper instead. To give the car pictured here the desired marque identity, the grille was shaped like an outsize Audi plum.

'Aerodynamics continue to be very important for Audi,' says Warkuss. 'To improve the drag coefficient, we are working on an almost flush floorpan. Glass with a varying degree of tint will heep the heat intrusion at bay.' The car will have quite a small glasshouse.

VOLKSWAGEN

HERBERT SCHAFER

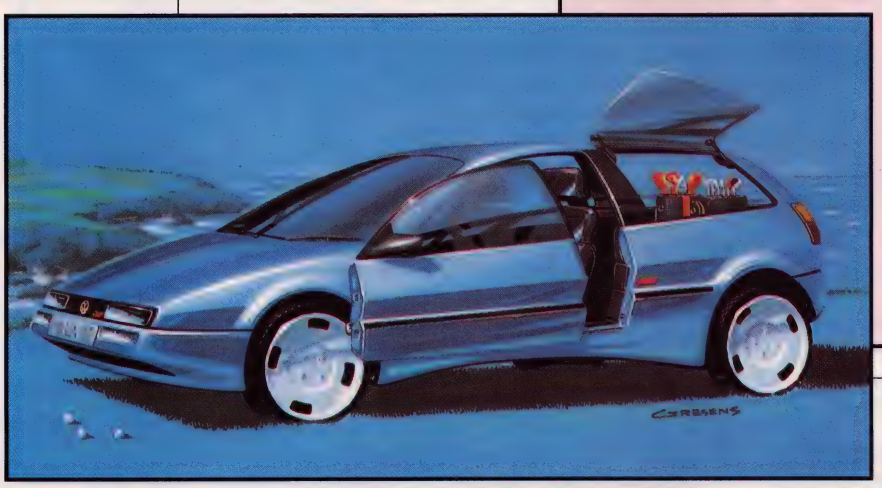


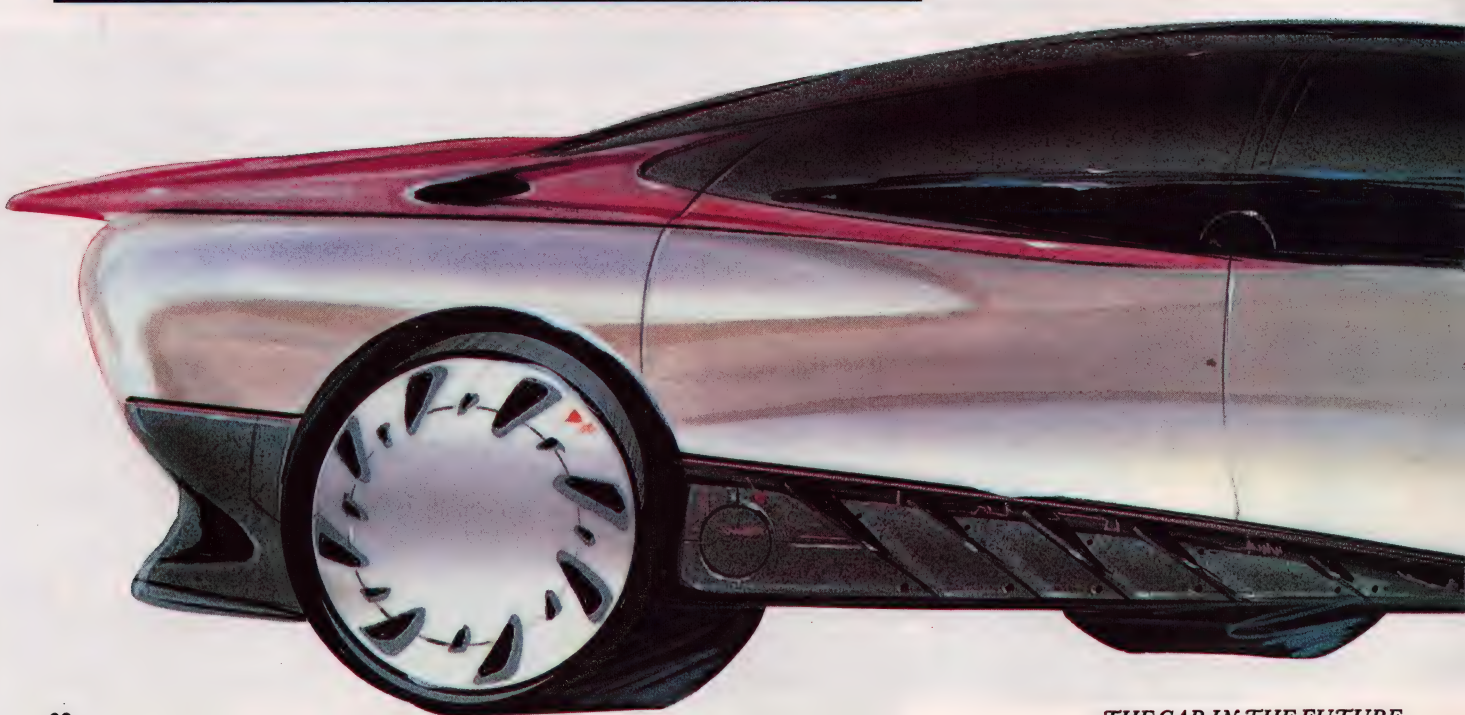
Born: *1932*
Previous employers: *Auto-Union, Mercedes-Benz*
Chef d'oeuvre: *Golf Mk2*
Characteristic strength: *created the world's first long-roof volume car, the VW Polo hatchback*
Dream car: *Jaguar XJ12*
Favourite colour: *a clear, intensive blue*
Hobbies: *woodwork, golfing*

Future concepts: 'We are going to see interesting developments in one-box designs. I also believe that the inexpensive roadster or speedster has a future. Modular body-styles on the other hand are likely to end up in a cul-de-sac. On paper, they are convincing. In real life, they call for too many compromises.'
Exterior design: 'The trend is that there is no trend. Since every manufacturer tries to create an individual style, we can expect more fashion-conscious, daring and varied solutions, most of which are likely to be rather short-lived.'
Interior design: 'I expect softer and better integrated shapes. We are going to look at the dashboard, the seats and the door panels as one entity instead of as individual elements. Bright colours are in, and so are new materials and trendy applications.'
Company styling traits: 'The VW badge is going to be an even more prominent symbol. But the cars that wear it must change all the time. We have to be very flexible.'

'A multi-purpose vehicle does not have to be a mini-van,' says Schafer. 'I am more interested in a compact sports utility that combines driving pleasure and practicality. To turn it into a really competent all-rounder, I equipped my dream car with four-wheel drive and height-adjustable suspension.'

Also high on Schafer's priority list is easy access to the cabin and the cargo area. That's why the moustached designer opted for sliding doors and top-hinged rear side windows. Unusual styling elements include a long roofline, short overhangs, a steeply raked windscreen and tapered sills. Unlike his colleagues, Schafer created a down-to-earth package which will soon influence production models.





BMW

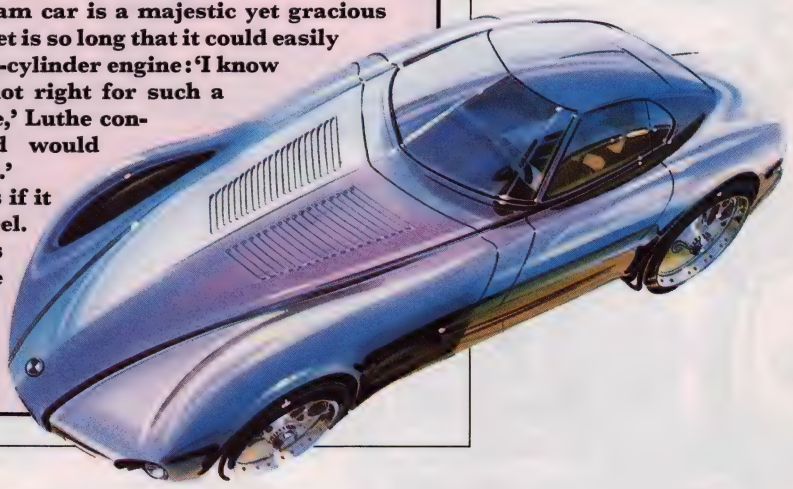
CLAUS LUTHE

Born: *1932*
Previous employers: *Fiat, NSU, Audi*
Chef d'oeuvre: *NSU Ro80*
Characteristic strength: *a sense of timeless proportions*
Dream cars: *most early Pininfarina designs, and the Ferrari 250GTO*
Favourite colour: *red – the deeper, the better*
Hobbies: *hiking, classical music, jazz, photography*

Future concepts: 'The minivan is definitely a coming thing. This is a trend we at BMW must watch closely.'
Exterior design: 'I don't expect much more progress in terms of aerodynamics. But I see a future for even more homogeneous shapes with more glass, and for cars which are both sporty and elegant.'
Interior design: 'We are spending more and more time in the car. That's why we must further improve the creature comfort, the standard of equipment and the ergonomics.'
Company styling traits: 'For BMW, that's the kidney and the kink in the C-post. The four round headlamps on the other hand are not a necessity.'

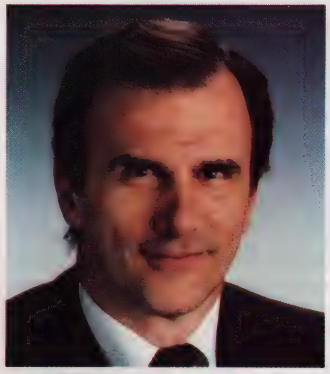
Claus Luthe's dream car is a majestic yet gracious dinosaur. Its bonnet is so long that it could easily accommodate a 24-cylinder engine: 'I know that the time is not right for such a voluptuous vehicle,' Luthe concedes. 'No board would okay this monster.'

The car looks as if it has muscles of steel. The huge tyres barely fit under the tight wheelarches, and the cabin is an intimate glass cocoon for two.



VAUXHALL

WAYNE CHERRY

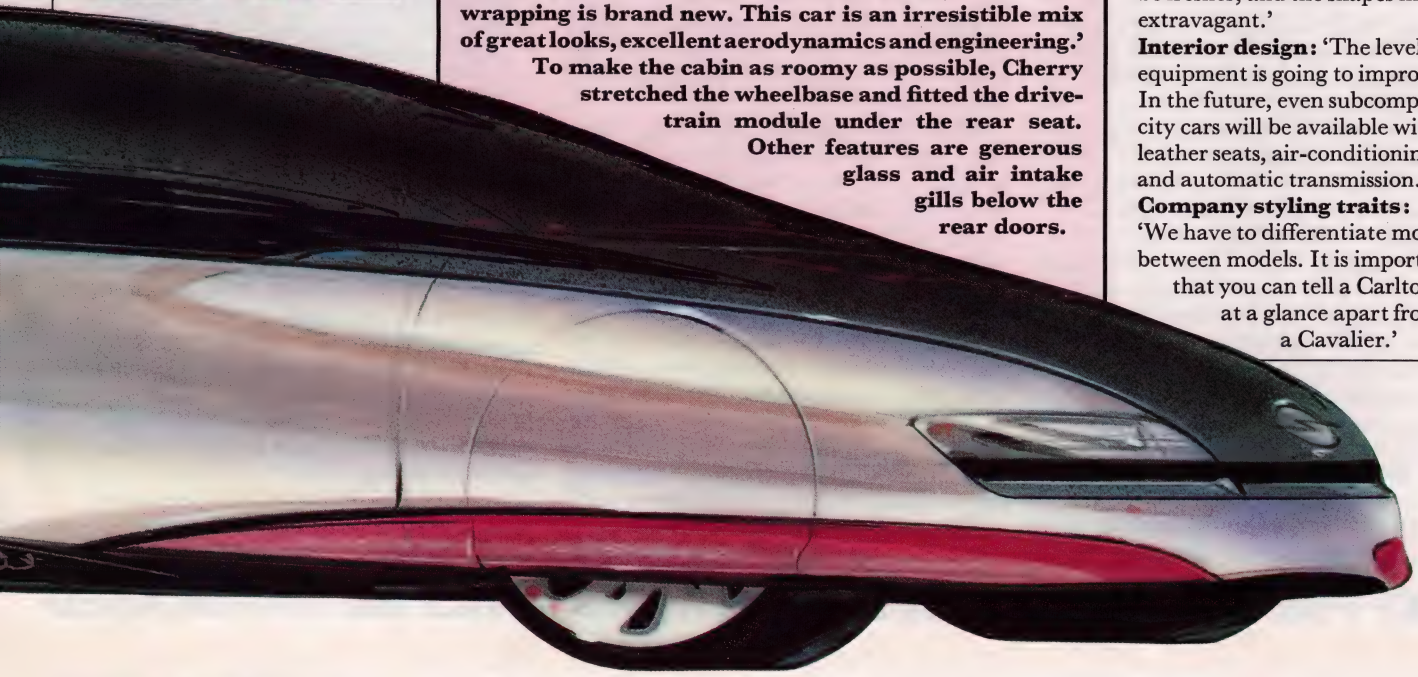


Born: *1937*
Previous employers: *General Motors, Vauxhall, Bedford*
Chef d'oeuvre: *Cavalier/Vectra*
Characteristic strength: *cost-consciousness, feeling for the kind of cars people want to buy*
Dream cars: *Ferrari 275GTB, Rolls-Royce Silver Cloud*
Favourite colours: *grey metallic, silver, black*
Hobbies: *his cars, antiques*

Vauxhall-Opel desperately wants to get rid of its bread-and-butter car image. One possible solution to this problem is the creation of a high-tech niche car to which end, Wayne Cherry has conceived a four-seater mid-engined coupe which mates the dynamics of a sports car to the family appeal of a saloon.

'The parts come off the shelf,' he says. 'But the wrapping is brand new. This car is an irresistible mix of great looks, excellent aerodynamics and engineering.'

To make the cabin as roomy as possible, Cherry stretched the wheelbase and fitted the drive-train module under the rear seat. Other features are generous glass and air intake gills below the rear doors.



Future concepts: 'I expect an even greater variety of shapes. In addition to purpose-oriented cars, such as the minivan, we are going to see more fun cars, whose design will be both exciting and functional.'
Exterior design: 'With a little courage, we'll come up with new lines and more daring proportions. The cars will become more elegant and more homogeneous; the colours will be fresher, and the shapes more extravagant.'
Interior design: 'The level of equipment is going to improve. In the future, even subcompact city cars will be available with leather seats, air-conditioning and automatic transmission.'
Company styling traits: 'We have to differentiate more between models. It is important that you can tell a Carlton at a glance apart from a Cavalier.'

JAM TOMO

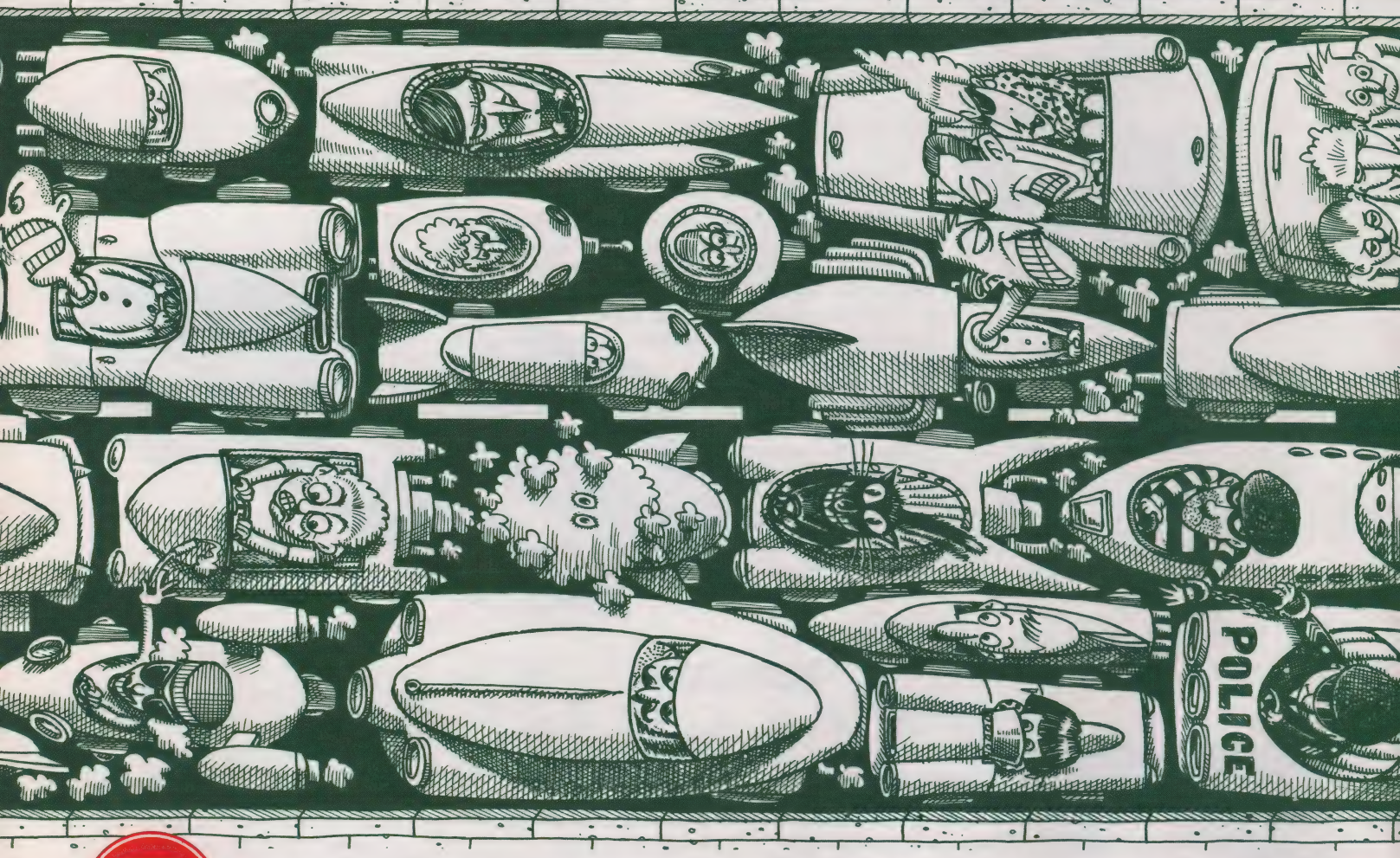


Illustration by Simon Cooper

STOP

START, CLUTCH-PUMP, stall, horn, seethe. If you think traffic delays are bad now, just wait another few years. The Department of Transport predicts that car traffic alone will increase by between 27 and 47 percent by 2000, and between 83 and 142 percent by 2025. And although Britain has one of the lower car ownership levels in the world – 310 per 1000 against 552 in the USA – saturation will occur once we reach 650. At present growth rates, this level could be reached by 2025, but everything could come to a halt much sooner than that.

Such forecasts aim to provide an up-to-date basis for the planning and appraisal of new roads. However, the National Audit Office's inquiry into Road Planning (November 1988) found that the average margin of error for such forecasts was 28 percent. In the case of the M25, the projected number of users was underestimated by 105 percent. Statistics may be questionable sources of information, but when it comes to dealing with serious road congestion in the future, who has the answers?

The British Road Federation believes you can build your way out of the problem, and wants a larger network of national and local roads. It was, not surprisingly, disappointed by Transport Secretary Cecil Parkinson's recent decision to scrap the proposals contained in the London Road Assessment Studies. Instead of £4 billion-worth of roads and tunnels, a much more modest £250 million programme of junction and roundabout improvements has been initiated. BRF director Peter Witt commented that: 'Doing nothing is not a solution . . . travel and environmental conditions will get worse with congestion extending over longer periods.'

What might keep the road lobby happy and busy are self-financing 'toll' road schemes, which Cecil Parkinson is keen to encourage: 'We are willing to consider proposals for the private financing of any scheme in the roads programme.'

But the pressure group Transport 2000 doubts that tolls would pay their way. Calculations by Dr Stuart Cole at the Polytechnic of North London, based on M25 traffic flows, indicate that they would have to charge £20 to £60 per trip. As a result, the bulk of the traffic would divert to, or stay on, existing roads, simply exacerbating the problem.

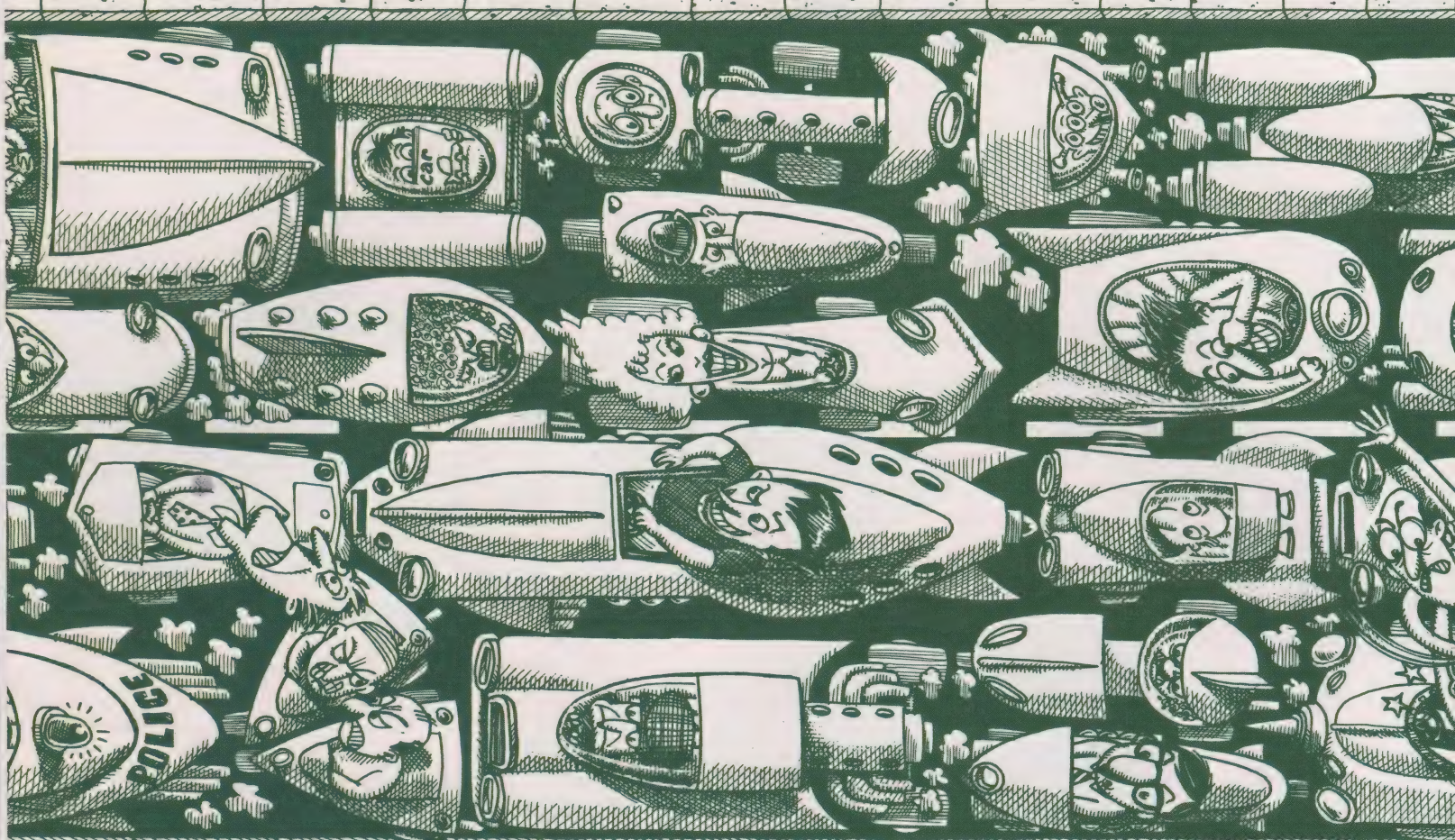
Dr Martin Mogridge of University College London suggests that only improvements to the public transport system will actually improve road speeds, a view shared by the Labour Party. Its transport policy document, *Moving Britain into the 1990s*, sresses that: 'Good public transport can play a major role in relieving congestion.' To this end it proposes to increase investment in railway rolling stock, track, staff and new rapid-transport systems. In addition, it will impose a statutory duty on local and regional authorities to ensure that there is a proper network of public transport that meets minimum standards for quality of service. *Turning Trucks into Trains*, a research report published in July 1987, concluded that the Channel Tunnel could reduce road congestion, because it would encourage more freight to move by rail – provided the rest of the network was up to scratch.

The Confederation of British Industry concurs with these findings and its report, *Trade routes to the future*, emphasised that the flexibility afforded by roads will continue to make it the preferred mode for the vast bulk of business traffic well into the next century. As a result, the movement of vehicles, particularly private ones, will have to be severely restricted in towns and city centres, especially if public transport is to operate more efficiently. Indeed, Department of

'AT PRESENT GROWTH RATES, ROADS WILL BE SATURATED

) R R W

That's the only thing certain about traffic in future/James Ruppert



Transport figures prove that of the 327.9 billion vehicle kilometres covered by vehicles in 1988, 82.4 percent was attributable to cars, and only 1.1 percent to buses.

Labour's proposals for the urban areas include allowing access to essential vehicles only at peak hours, tougher penalties for illegal parking and more effective enforcement of the traffic laws. It will also encourage local and regional authorities to develop 'traffic-calming' measures in residential areas along the lines of those that are already common in Cologne and other European cities, such as reduced speed limits and road humps.

Other schemes that aim to ration scarce road space include the AVI toll system, already in use in the United States and recently endorsed by the Chartered Institute of Transport. It comprises vehicle-borne tags, roadside reader units and a computer system that bills users on a monthly basis. Already, SCOOT (Split Cycle and Offset Optimisation Technique) is being used in Southampton, enabling traffic lights to change according to traffic density.

If these measures fail, the last resort is to get people out of their cars altogether. The Labour Party believes it could persuade more employees to switch from company cars to public transport by taxing this perk more fairly. A poll commissioned by five London boroughs (*Public Attitudes to Traffic Restraint*) across the political spectrum in congested west London and carried out by Gallup, suggested that there was considerable public support for radical action; 82 percent wanted traffic reductions in central London, while 75 percent were prepared to accept some sort of restraint on the ownership of vehicles. The most favoured method was a reduction in road space for cars, together with its realloaction to buses, pedestrians and cyclists.

Although they are keen to reduce congestion, the public is predictably less enthusiastic about the ways in which this may be done. A nationwide AA survey found that the suggestion that no-one without a garage could own a car, unless they parked it either off the highway, or only on certain roads in defined areas, met with 74 percent disagreement. With the suggestion that households be allowed only one car, 70 percent disagreed. Only 27 percent supported the idea of payment per mile under a road-pricing scheme, while new toll roads, tolls to enter city centres and limited office parking, also received little support.

Although drivers may ultimately be forced to change their habits, there are some high-tech options open to the motorist which are likely to become increasingly important in avoiding trouble over the next decade. Autoguide is an information system guiding motorists away from congestion and bottlenecks. It uses a network of beacons on the roadside to monitor traffic flow and then relays navigational data to drivers via an in-car console. Similarly, the RDS information system gives motorists notice of congestion via specially adapted radios, which interrupts other stations with the latest bulletin.

If the statistics indicate that motorists are in for a busy time over the next few years, the policy makers are not saying anything to suggest otherwise. A spokesman for the Department of Transport emphasised that the on-going £15bn programme of road investment was committed to providing additional capacity, including substantial road-widening schemes, and supporting privately funded toll roads. However, Transport 2000 believes the roads of the future will largely be those of today. Consequently, traffic congestion cannot be dealt with solely by road construction. They point out that new roads actually generate more traffic and the suppressed demand for road space is almost infinite.

BY 2025, BUT WE COULD GRIND TO A HALT SOONER THAN THAT'

Sports cars don't have to furrow new technological ground to be exciting, and the new Mazda MX-5 Miata is proof. It unashamedly harks back to the great British sports cars of yore, and serves up traditional MG thrills: wind-in-the-hair fun, lovely evocative styling, pleasing mechanical simplicity, and an intimate cockpit for two.

But it's a far better car than any old MG: better made, better handling, sharper to steer, and less likely to strand you on the hard shoulder of a motorway on a cold winter's night. It offers all the charms of a great British roadster, but with few of the drawbacks. It's also surprisingly brisk, and 'green' – featuring an exhaust purifying

The fabulous new Mazda MX-5 Miata

WIN TH

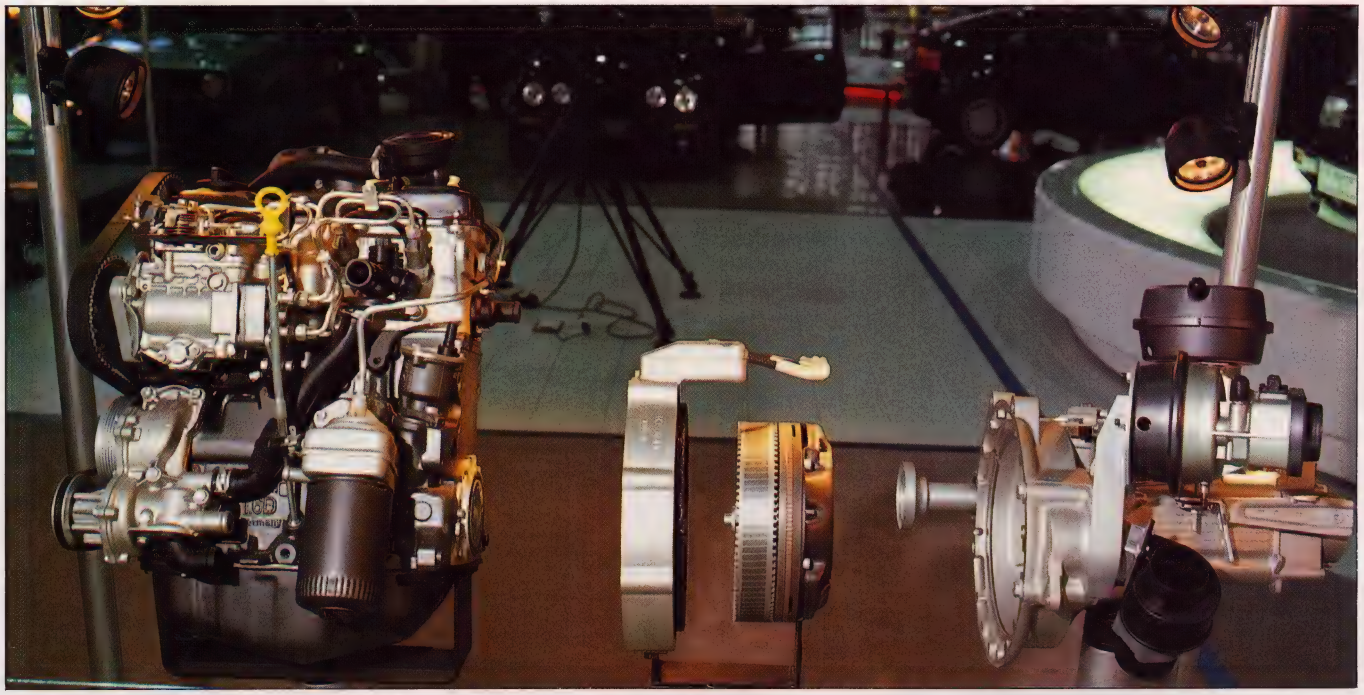
Photograph by Ian Dawson Lighting by Phil Tulk

catalytic converter as standard (which also means it must run on lead-free fuel). Old fashioned it may be in concept; but technically the new MX-5 Miata is right up to date.

And we're giving one away. Unlike most car give-aways, this one doesn't involve hours of swotting, to find the answers to obscure questions. You simply tear out the coupon, which appears on this spread, affix a first class stamp, and send it off. The winner will be chosen in a lucky dip. It's as simple as that. You may be sent insurance offers, by post, as a result of entering the competition.

The winner's car – worth £14,249 – will be available for collection in July. As with all British-specification MX-5s, it features power-steering, electric windows, alloy wheels, and a blissfully easy-to-operate hood.

IS CAR!



Electric motor and clutch (centre) are sandwiched by engine and gearbox

THIS YEAR'S STAR CAR AT the Geneva show will go down as one of the most unconventional there's been, but perhaps the most prescient. What was it? A three-year-old Volkswagen Golf with over 60,000km on the clock. True, it sported some rather garish striping over its plain white paintwork, but that aside, it was about as diverting as a crack in the pavement.

What makes it special lies under the bonnet. This car is a hybrid, so called because it is powered by two engines, one diesel, the other electric. The point of the extra complication is, of course, ecological, and the beauty of the system is that it tackles several environmental problems simultaneously. Energy consumption, for example, is significantly reduced, the Golf turning in 113mpg on the urban cycle test. In normal use, you could expect it to go around 100 miles on a gallon of diesel, supplemented by energy taken from its batteries, which are charged from the mains.

Pollution is dramatically curtailed, too. Again on the urban cycle, oxides of nitrogen, already low because the engine is a catalyst equipped diesel, fall by 60 percent. Emissions of carbon dioxide, the greenhouse gas, are cut by more than 50 percent, and the production of hydrocarbons and soot falls off, too.

Dr Adolf Kalberlah, project leader

The benefits don't end here, either. When electricity is the motive power, the Golf is exceptionally quiet – important with the promise of much stiffer noise regulations on the horizon. It will last longer, too, because the diesel engine won't wear out as quickly, being intermittently relieved of duty by an electric motor with no sliding parts.

The electric motor is mostly for use in town, when brisk acceleration and high speeds aren't needed. The diesel intervenes either when more urgent acceleration is demanded, or once the car reaches 37mph. The engines only ever operate singly, and their activities are electronically controlled – you simply drive the car as you would any other.

That's the theory at least. Practice is undermined by a couple of factors – first, the semi-automatic transmission, which provides you with a standard four-speed manual gearbox, but no clutch, the second, and it's more serious, the noises emanating from under the bonnet.

In electric mode you could close your eyes and imagine you're aboard a milk float, so familiar is the motor's subdued whine. Should a little more oomph be required, however, you'll be assailed by an abrupt increase in decibels when the diesel engine cuts in. The intermittent din is somewhat disconcerting. It takes getting used to.

So, how does the Hybrid work? In a word, ingeniously. The asynchronous electric motor is remarkably compact, being just over two inches wide, and it sits between the diesel engine and its end-on gearbox. Flanking the electric motor is a pair of clutches which are built into the rotor. One provides a direct connection to the gearbox, the other to the diesel engine because, and here's the clever part, it doubles as a starter motor and an alternator, too.

Clutch doubles as inner portion of electric motor – it's just 2in wide

As Dr Adolf Kalberlah, the Golf Hybrid project leader says, it's an elegant solution. The clutches are automatically operated, engaged and disengaged by servos that are triggered by a micro-switch in the gearlever knob.

The electric motor is powered by a 72-volt set of batteries located in the Golf's boot – they occupy the space of a medium-sized suitcase – and it's controlled by a DC-DC chopper, which rapidly switches the electricity supply on and off to deliver the power demanded

VOLTSWAGEN

Richard Bremner drives a diesel-electric VW

Prototype is three years and 40,000 miles old, looks standard bar loud paint

Batteries and control box live in boot, will eventually be moved under floor

by your right foot, as in a normal car.

The batteries have enough energy to propel the car, unaided by the diesel, for about 28 miles. They must then be recharged from the mains, which can be completed overnight. This may not sound much of a range, but battery power is only used in urban conditions, and few people are likely to need more than this in a day. Used exuberantly on its own, however, the six kilowatt electric motor is capable of draining its three kilowatt power source in only half an hour. But in practice, the charge lasts a lot longer than that.

Volkswagen has found that in typical city use, the electric motor will be running 50 percent of the time, the diesel 25 percent and the remainder will be coasting, when neither motor runs. The battery's charge is also preserved by the fact that full power won't always be demanded of the motor, and by the regenerative braking system which produces a small boost for the battery every time the anchors are used.

This regenerative system is the only form of battery recharging aboard the Golf. Other hybrid systems make use of the diesel engine to replenish the batteries when it isn't propelling the car, allowing a greater range under electric power. VW reasons that this method is less efficient, and more polluting than drawing current from the mains.

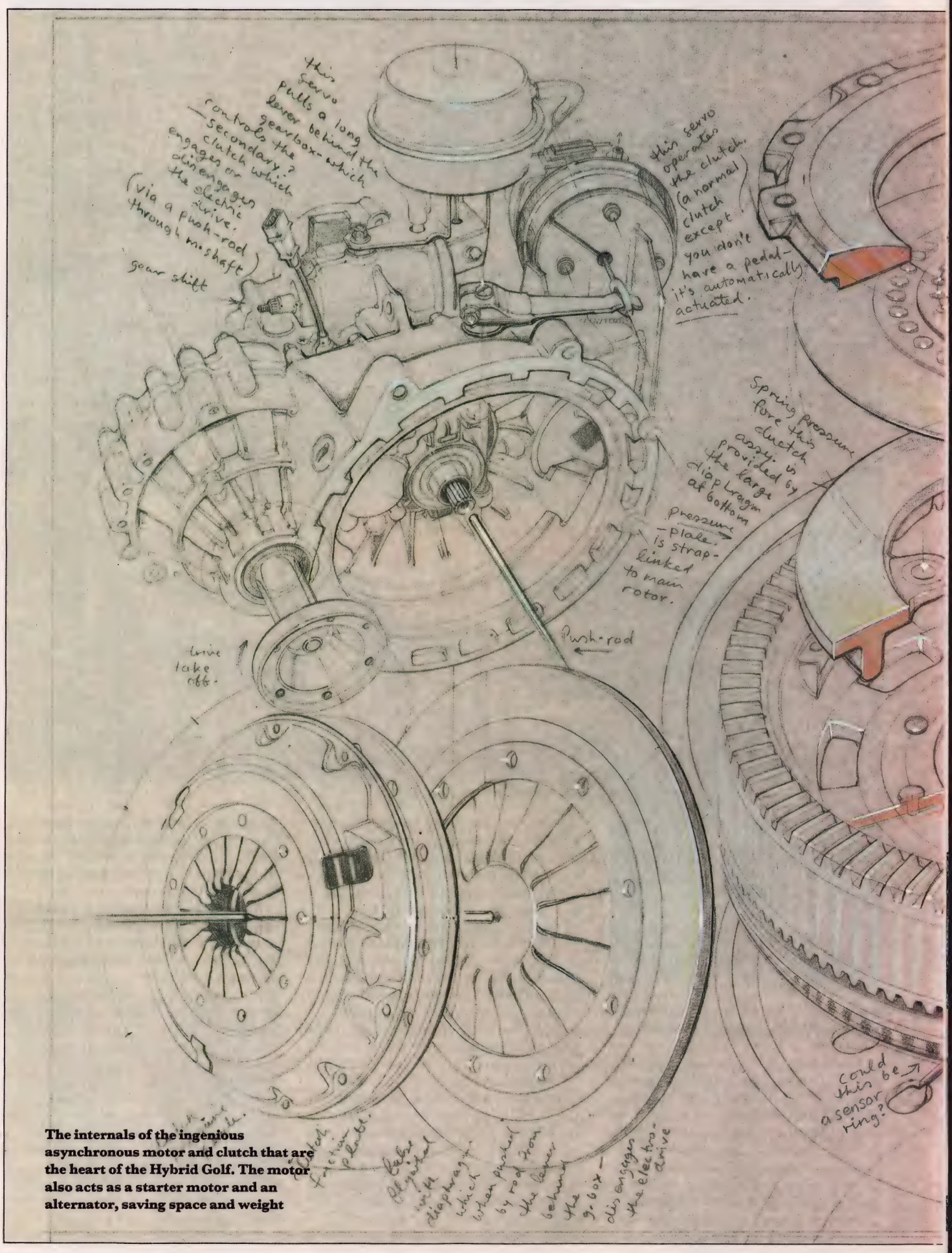
So it is possible to drain the batteries, though not completely because they retain 25 percent of their charge in order to power the electric motor in its role as a starter for the diesel. Without this, the Golf would be marooned.

If all this sounds complex, it becomes less so once the car is familiar. But there's a fair bit of acclimatisation to undergo, and it starts as soon as the driver's door is opened. This triggers the electric pump that accumulates vacuum pressure for the clutch servoes. It whines for a few moments – long enough to notice that, though there's a four-speed manual gearchange, there's no clutch pedal.

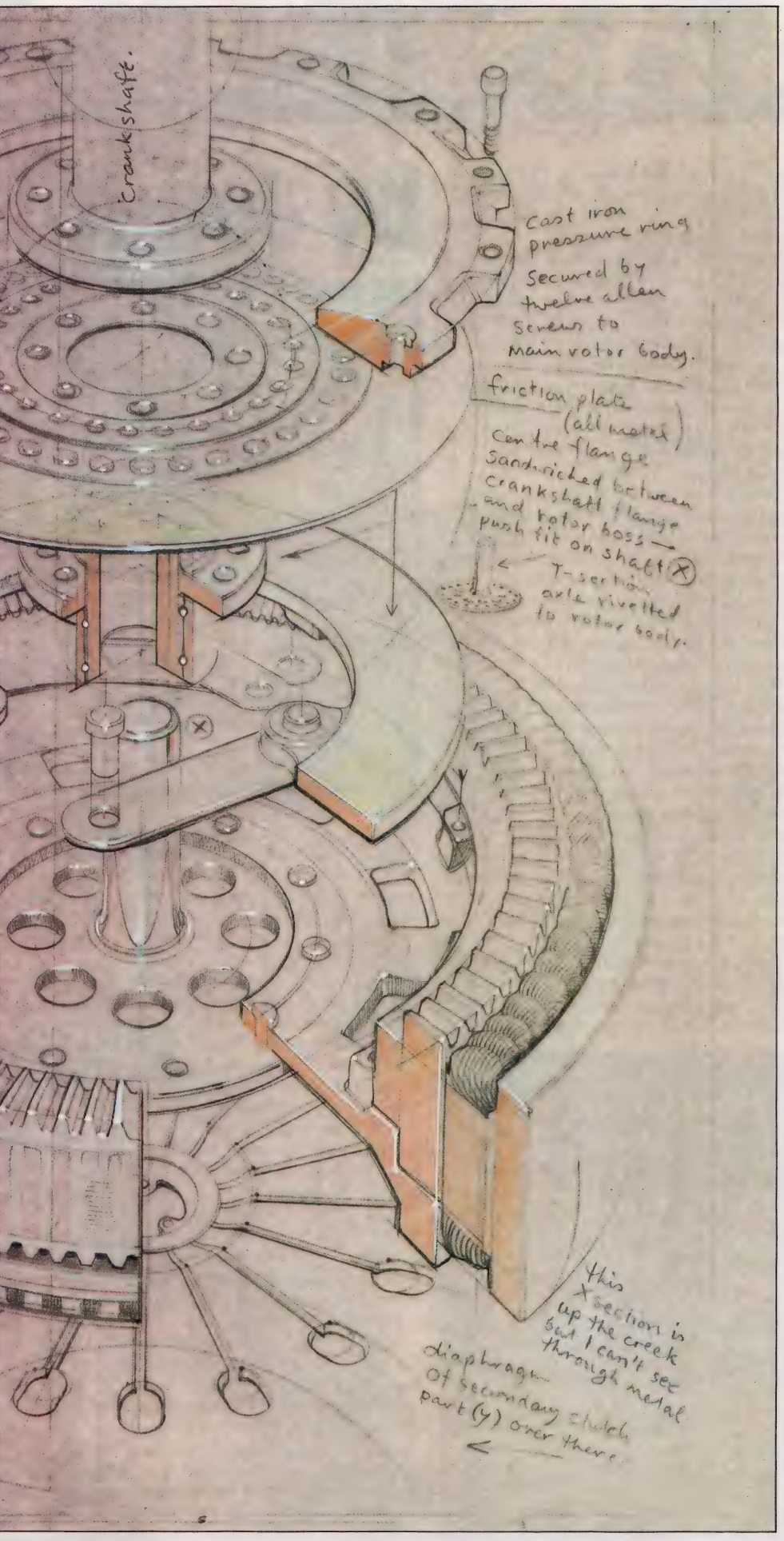
Flip the ignition key, and there's virtual silence. The Golf's electrical circuits go live, but the engines are dormant – they only turn when a gear is engaged, to save fuel. Selecting first gear prompts a brief, smooth whirr as the electric motor, in its role as starter, spins up to 700rpm and seconds later, the diesel engine starts.

The diesel engine always operates

Photographs by Richard Newton



The internals of the ingenious asynchronous motor and clutch that are the heart of the Hybrid Golf. The motor also acts as a starter motor and an alternator, saving space and weight



when the car is in first gear because it's swifter, and therefore safer, during the crucial business of pulling into fast-moving traffic. But it is possible to flick a switch and run the car entirely on volts.

What happens next depends on how briskly you want to go. If speed is needed, the diesel keeps running. The car drives like an oil-burning Golf (with respectable zeal and slightly too much din) except that there's no clutch pedal to compress – instead, the clutches are triggered by a micro-switch in the gearlever knob. You shift gear normally, taking your foot off the accelerator as in a conventional car.

If progress is more sedate, however, the diesel goes dead, to be relieved by the electric motor. The transition from one to the other is seamless 90 percent of the time – occasionally, though, there can be a slightly disturbing jerk. More often than not, this is provoked by moving the gearlever too slowly.

If you take more than one-and-a-half seconds, the underbonnet electronics assume that less urgent progress is required, and the car goes into electric mode. Which is fine if it was already under electric power, but irritating if you wanted to stay with the diesel.

That's one way the car detects your driving style – the other is via the accelerator. Once it's pressed beyond a certain point, the diesel motor is fired up, to provide extra effort at low speed. The engine also cuts in once the car exceeds 37mph.

Both engines stop altogether when Hybrid is decelerating, and when it's stationary, provided the gearlever is in neutral. All this takes some getting used to, though doubtless a week at the wheel would be sufficient acclimatisation.

It's reasonable to expect that a lot of people may find the Hybrid too much of a technological leap to make. True, it is a prototype, and a relatively early one at that, but it's hard to see a noise pattern like this being adequately disguised.

But, of course, car buyers may eventually have no choice. Willi Josefowitz, one of the Hybrid's development engineers, doesn't believe it would sell well in today's climate, not least because the car would cost substantially more than a standard Golf Diesel. But if there were tax incentives, or restrictions on the use of fossil-fuelled engines, then cars like these could have a big future. Hybrids are where we'd lay our money as the most likely solution to the car's environmental problems in the near future – say 15 to 20 years.

Before that, VW plans to build at least 20 more Hybrid Golfs, which are to be part of a field experiment in Zurich involving the university, public authorities, the electricity company and ordinary car drivers reporting their experiences. That's not many cars, but it could be the start of a major new trend.

Illustrations by Bob Freeman

THE CASE AGA

by Jonath

I WOULD BE THE FIRST TO acknowledge that the private motor car has brought many benefits to literally millions of people. It offers convenience, comfort, privacy and mobility – for at least some of the time – and has understandably become the dominant symbol of increasing prosperity throughout the world. So, why does it feature so large in the demonology of the Green Movement?

Not even the most manic motoring enthusiast would deny that many costs have also been incurred as a result of our collective obsession with the car. Cities designed primarily for the convenience of the motorist are hostile and dirty places in which to live; the toll in terms of death and injuries from road accidents is appallingly high; terrible damage has been done to the environment through the contribution of car exhausts to acid rain and global warming.

Nearly 20 percent of the United Kingdom's carbon dioxide emissions are related to road transport, and it is the same in most other industrialised countries. Each car produces nearly four times its own weight in carbon dioxide every year.

Though scientists may differ about the speed and extent of climate change, very few dispute that a temperature increase of between 1.5degC and 4.5degC is inevitable over the course of the next 100 years. In climatic terms, that represents an extraordinarily rapid transition, and the different scenarios projected as a consequence of it, vary from the very worrying to the utterly disastrous.

The success of the car industry since World War Two has been dramatic: the number of cars on the world's roads has risen from around 50 million in the late 1940s to around 400 million in the 1980s, and it continues to rise. More than one third of these cars are in the United States, but demand elsewhere is soaring.

Between 1970 and 1985, the Soviet and Eastern European car fleets grew five-fold, and there is no doubt that the process of democratisation in Eastern Europe will guarantee a massive expansion in vehicle transport in those countries. Indeed, Western European economies are counting on it; expectations of an upturn in growth are partly dependent on the speed with which consumer demand accelerates in Eastern Europe.

Though well below that of industrialised countries, car ownership in the Third World was also rising until the mid-1980s, when the debt crisis began to bite. Indeed, aid and trade programmes are often geared to promoting increasing vehicle use, and many Third World governments are intent on making this a priority in order to enhance their own prestige and standing.

Both globally and in the United Kingdom, there is a complete contradiction between our awareness of global warming and the continuing promotion of the motor car as the favoured mode of transport. Although it is now almost universally accepted that new roads simply generate new demand, the Department of Transport responded to the Prime Minister's growing concern about global warming by producing a report in 1989 projecting increases in British vehicle number of between 80 percent and 140 percent by 2020!

Transport consultant John Adams has pointed out that the extra vehicles involved would form a queue 124,000 miles long. If stationary, this could be accommodated on a brand new motorway stretching from London to Edinburgh – if it were 306 lanes wide! Given current levels of congestion, let alone pollution, such an increase is an almost inconceivably stupid notion.

'The number of extra vehicles on British roads between now and 2020 should form a queue 124,000 miles long. That would fill a motorway from London to Edinburgh - if the motorway was 306 lanes wide'

To date, not a single mainstream politician in this country has had the courage or vision to stand up and say that UK transport policy should now be geared quite specifically to making our city centres entirely car-free by 2010, and *halving* the number of cars on our roads by 2025. It's certain that something of this order will be required, if we are to make any kind of contribution to reducing our emissions of greenhouse gases and air pollution.

Given the crucial role which the car industry plays in our economy, it's hardly surprising that no-one is seriously talking about life after the motor car. Our growing awareness of global warming has merely sharpened the debate on how we might endeavour to make the motor car more 'environment friendly'.

But is it actually possible to achieve this? Using unleaded petrol is now seen as just the start of cleaning up our automotive act; from now on, more and more cars will be using catalytic converters, which will eliminate up to 90 percent of pollutants, such as hydrocarbons and nitrogen oxides. However, they will still do nothing whatsoever to reduce carbon dioxide.

So, the next step is to increase fuel efficiency. Various prototypes currently being developed by Peugeot, Renault,

INST THE CAR

on Porritt

THE EARTH

Volkswagen, Toyota and Volvo are achieving anything between 75 to 125 miles per gallon. So-called lean-burn engines (both petrol and diesel); the development of gas turbines; the introduction of ceramic components: all these will play an important part in engine design during the 1990s.

Further improvements in efficiency can be achieved by increasing the average number of passengers carried in each car on regular journeys, as has been done in Singapore and Hong Kong. However, even if we succeed in doubling fuel efficiency over the next 15 years by these means, if we simultaneously double the number of cars, the net environmental benefit in terms of carbon dioxide reduction is absolutely zero.

Hence, the increasingly enthusiastic search for alternatives to oil as the main automotive fuel. The main contenders here are the alcohol-based fuels, ethanol and methanol, from agricultural crops or wastes, and natural gas. By spending around £5 billion on a programme to produce ethanol from sugar, Brazil succeeded in reducing oil imports by 60 percent between 1979 and 1986. But there are many problems with alcohol-based alternatives.

Vast amounts of land are required to substitute for any significant proportion of current petrol consumption. The World Watch Institute has calculated that up to 40 percent of the entire United States corn harvest would have to earmarked for ethanol production in order to meet just 10 percent of current fuel demand.

THE CAR IN THE FUTURE

The next pipedream down the road is to make all our vehicles battery-powered. It takes a while to persuade enthusiasts that this makes no difference whatsoever if the electricity to recharge the batteries is generated from fossil fuels, or nuclear power. For any environmental benefit to be derived, electric cars will have to be powered by the sun (through the use of photovoltaic cells), or by fuel cells (which convert the chemical energy in a fuel such as methanol directly into electrical energy). A methanol-based fuel cell for cars is currently being developed by General Motors.

Lastly, there is the hydrogen car. Both BMW and Mercedes-Benz have hydrogen-fuel versions of some of their existing models, and both believe that it will be possible to solve the difficult problems of storage and safety, but they still reckon it will take another 40 years to develop the technology commercially.

In January 1990, BMW also announced that it was to build a 'car recycling plant' and, together with other manufacturers, is already researching the use of plastics suitable for recycling. Such an advance would clearly help, but it would not solve the basic problem.

Even if we let our technological dreams go all the way down that particular road, the uncomfortable truth is that *no* car, however efficiently it uses the cleanest of fuels, can be described as environment friendly, simply because of the energy and raw materials needed to produce it, the roads it requires, and the vast infrastructure of garages necessary to keep it on the road.

The only solution over the next couple of decades is to build up our public transport systems, both within and between cities. We have all heard this a thousand times before, but one has to keep on saying it; the message still hasn't go through to Transport Secretary Cecil Parkinson, for instance, who claimed at the end of 1989 that 'public transports improvements are unlikely to achieve a major reduction in road traffic and congestion'.

Little wonder that he continues to reduce the level of support for British Rail (from more than £1 billion in 1983 to well under £500 million by 1992), and little wonder that the UK will be left on the sidelines yet again, as the rest of Europe signs up for the impending revolution in high-speed trains and in new rapid-transit and light rail systems. Continental-style trams *are* being actively promoted in Bristol, Southampton, Sheffield, Leeds and Manchester to provide a high-quality commuter service. But in comparison to many other European countries, Britain's public transport services still look like museum exhibits.

With massive public investment, there is little doubt that we could end up with a kind of integrated public transport system that all members of the travelling public dream of. But even that is not necessarily green. We must go one stage further, and ask whether all those journeys are necessary.

The greater the number of people who have to be conveyed regularly from where they live to where they work, the greater the environmental damage. Even trains, buses and trams gobble up energy and raw materials. Our long-term goal must, therefore, be to ensure that as many people as possible live and work within walking or cycling distance, or at least within reach of a local public transport system. And that means no more commuting.

'Nearly 20 percent of the UK's carbon dioxide emissions come from road transport, and it's the same in most industrialised countries. Every car produces nearly four times its own weight in carbon dioxide every year'

Volkswagen Corrado.
[illegible], that's too good for words.

[illegible] will ever, because of this, be top of mind.

From a standstill to sixty time of 8.1 seconds will be spoken of in less as naught.

We could natter on about horsepower. [illegible] of the thoroughbred beasts lurk beneath the bonnet.

Equally, though, it would seem equally beneficial to explore the result of the 2.15 at Kempton Park.

We could, of course, fill the space with consummate ease by describing a capacious boot and an interior with more than enough elbow room for four hulking passengers.

Wax lyrical about body cavities brimming over with anti-corrosive hot wax.

Sprout on about a rear spoiler that rises automatically at 40 miles per hour.

For the scrupulous scribe, the car offers more material than one could shake a spear at.

Woe's the pity.

Because, while the pen might justly be deemed to be mightier than the Ford, it's clearly no match for a Volkswagen Corrado.

Corrado

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FORTY YEARS AGO, the motor car consisted only of basic ingredients such as metal, rubber, glass, wood, leather and paint. Now, however, no fewer than 600 different materials are used in the typical car. In the scrapyard, where all vehicles end up, these components and liquids become one shapeless lump worth under £80. As raw materials get scarcer and more costly, the motor industry realises that its environment-consciousness must not be restricted to lower emissions. But recyling a motor car is a difficult task.

The steel content of the car has dropped from 76 percent in 1965 to 66 percent in 1989, but that's about as low as it will go. After all, steel is relatively cheap and easy to handle. It's also straightforward to recycle, provided you gut the car properly and drain all the fluids. Thus prepared, the skeleton is ready for the shredder. The troubles start when trying to deal with the other 599 materials. And plastics are a lot harder to handle than the rest.

Between 1965 and 1985, the percentage of synthetic components used in cars climbed from two to 10 percent: 'But from now on, the growth rate of plastics will be very slow,' predicts Gert-Dieter Werner, who runs the research division for non-metallic materials at BMW. 'I see plastics going to no more than 12 to 15 percent of a car's content by 1995. The current euphoria relating to plastic composites is totally unjustified because the disposal still causes plenty of problems.'

There are three different types of plastics: thermosetting plastics, elastomers and thermoplastics. Unfortunately, around 80 percent of all plastics are of the thermosetting kind, not suitable for recycling. If it wasn't for the poisonous gases which call for complicated filter systems, these composites could be burned up and converted into energy. But since this is impractical, the industry tends to grind them and use the by-product to surface tennis courts and sports arenas. A similar fate awaits the elastomers, which can be used as synthetic substitutes for rubber.

Thermoplastics, on the other hand, can be recycled up to three times. In the first cycle, an old bumper is still good enough to become the backbone of a dashboard. In the second cycle, the dashboard becomes a firewall cladding or a protective skin inside the wheelhouse. For the third cycle, the manufacturer needs to add fresh raw material to bring back the original properties.

'Unfortunately, thermoplastics seldom appear in pure, unmixed form,' says professor Christian Voy who works in Volkswagen's research department. 'They tend to be painted, coated or blended with additives. To separate them, it is vital to develop a marking system. In an ideal world, every new car would come with a recycling passport that lists all the synthetic components used.' A great idea – provided the car manufacturers and the suppliers agree on a common international norm, possibly a bar or letter code. It is just as important to design the cars so that the plastic bits can be easily disassembled.

In the course of a trial programme, the Dutch disposal specialist DSM has

'An old bumper can turn into a dashboard and that becomes a firewall'

begun to recycle bumpers and fuel tanks made of thermoplastics. DSM works hand in hand with GE Plastics which guarantees to buy back the materials it supplied in the first place. GE is about to set up a disposal network that will eventually serve the whole of Europe. A prototype facility has been set up in Munich where GE co-operates with the local junk yards. In 1990, the company expects to buy back some 300 tonnes of plastics. That sounds a lot, but it isn't compared with the 200,000 tonnes of synthetic materials annually ripped out of dead cars in Germany alone.

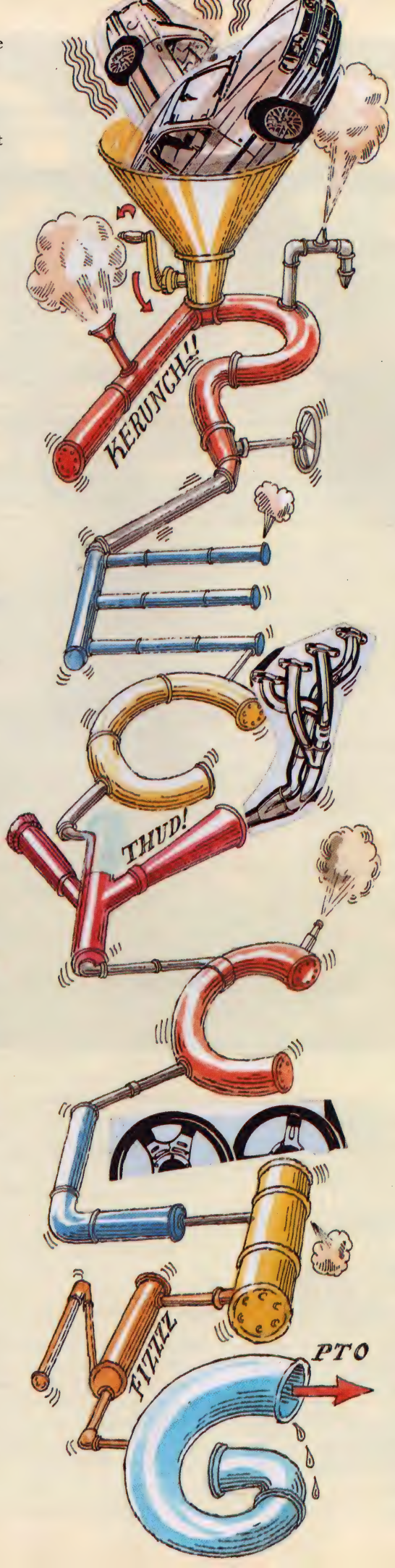
'It is just about time for

'We know that approximately 75 percent of a car can be recycled'

the law to create clear responsibilities,' says BMW's Werner. 'We know that about 75 percent of a car is recyclable. As far as the plastic components are concerned, it would make sense to involve the supplier in a lease-and-buy-back scheme. Such a move could help to slow down the so-called plastic mountain which is expected to triple in size by the year 2005. In a parallel initiative, we as a manufacturer must do what we can to substitute one-way materials with elements that can be used again.'

Like plastics, aluminium offers clear-cut advantages in the fields of corrosion resistance and weight saving. But unlike the various synthetic materials, light alloy can be recycled almost 100 percent. 'Unfortunately aluminium costs three times as much as steel,' remarks Jurgen Ziese, director of the central material development department at BMW. 'In addition, it is an energy-intensive material. But despite the high price, I expect aluminium to become even more popular over the next five years.'

BMW is currently experimenting with a steel structure clad in aluminium body panels. While the crashability of such a compound hull is surprisingly good, the



Illustrations by Peter Bailey

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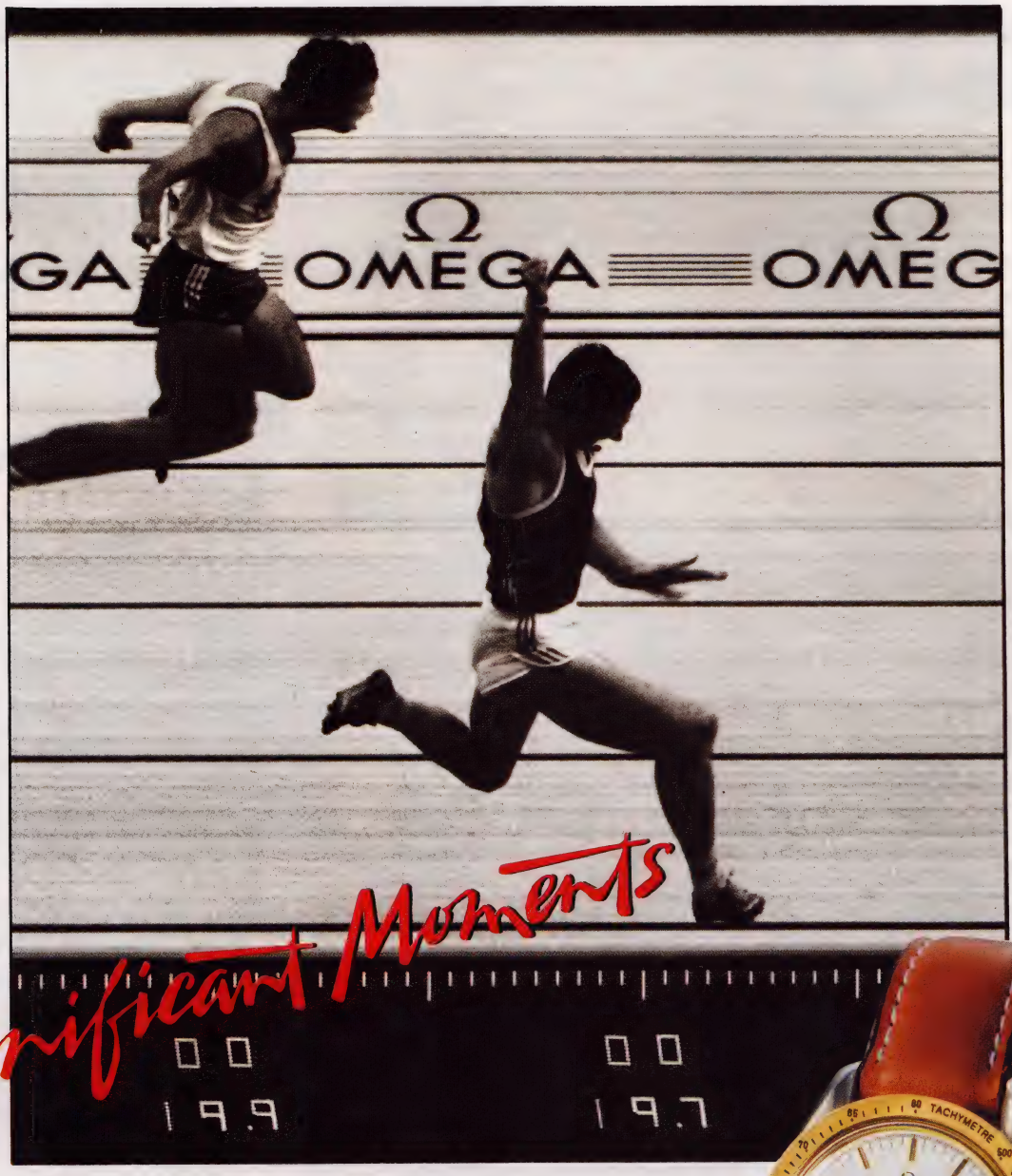

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mounting technology that combines the two materials is still in its infancy. The Bavarian engineers try to jump this hurdle by applying invisible rivets and ozone-resistant glue, but they have yet to master certain production problems as well as the corrosion through oxidisation which occurs when the surface is damaged.

Despite these reservations, aluminium remains popular among car company research and development engineers. The next-generation Audi V8 will, for instance, feature an alloy body produced in conjunction with Alcoa. Tests with the current car have shown that the switch to this lightweight material will improve the fuel consumption by up to 15 percent. At BMW, the engineers have developed aluminium suspension components for all existing models. Should there be another energy crisis, these items could go into production within a space of six months.

Although such changes would push up the price of the vehicle, in the final analysis the customers should benefit from the higher aluminium content. BMW's Jürgen Ziese explains: 'The fuel bills would be lower, and the owner could even get his money back in the shape of a scrap voucher which would be redeemable for cash when he turns in the old vehicle.' An internal study shows that the scrap value of a fully recyclable 735i with a high aluminium content is about £1900 – and that doesn't include any customer loyalty incentives which the factory might like to grant.

In addition to plastics, steel and aluminium, there are a handful of unusual materials that are suitable for recycling. Lead is one, and it is good to hear that 90 percent of the lead used in new car batteries has been used in batteries before. Platinum – used in catalytic converters – can also be recycled. While you get more than four pounds of this precious material out of a ton of scrap catalysts, one ton of ore will yield only three ounces.

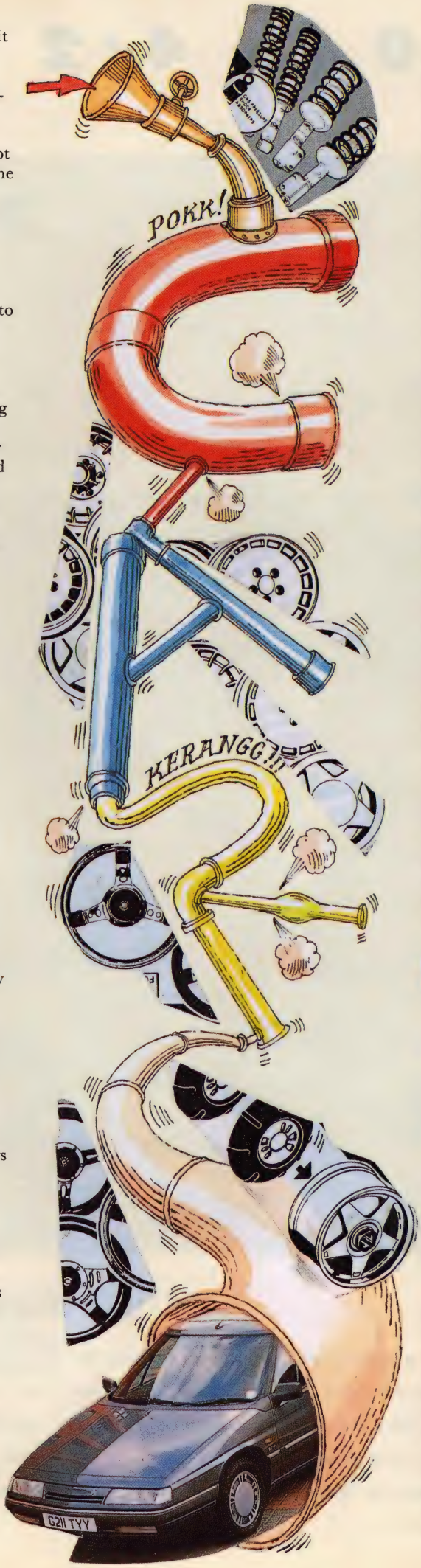
According to specialists it even makes sense to save items such as anti-lock brake systems and traction-control computers which can be used again because the related technology is not going to change much in the foreseeable future. This philosophy does, however, not apply to components such as engines, axles and transmissions which are prone to wear.

Fluids and gases belong to a grey zone where it's still early days for recycling. The gases that serve as propellent for air conditioning systems belong to this group, as does the propelling charge of the air bag, the power steering and brake fluids, or the oil inside the shock absorbers. To collect these materials and to dispose of them, the car makers and the

'It's useful to save the electronics, which can be used again'

suppliers must introduce special arrangements. They must, for instance, fit dampers with oil drain plugs and equip steering racks with bleeder screws. These are simple and inexpensive changes, and yet they are extremely difficult to enforce.

Although chemistry plays an important role in the composition of the motor car, natural materials are still being used where the top priorities are looks, feel and touch. This applies in particular to luxury models whose cabins are crammed with wood, leather and wool. Out of these three elements, only leather is unsuitable for straightforward recycling, but it can, together with sawdust and textile by-products, be processed into sound-deadening material, door panels, glovebox lids and the like.



Glass is another item which makes recycling specialists like Maximilian Wutz, senior engineer at Mercedes-Benz, prick their ears: 'There is no reason why windscreens, side windows and backlights should be used only once. After all, glass is perfectly suitable for recycling.' Once the lamination foil has been removed, the see-through crumbles have to be shovelled into a furnace where colouring matter is then added to produce an even tint.

Even paint is nowadays designed to be biologically degradable and water-soluble. Other basic materials such as steel or aluminium undergo high-tech treatments to meet specific requirements without losing their recyclability. Recently introduced processes include laser-coating and alloying additions which produce certain surface qualities (toughening, smoothness, conductivity) without affecting the chemical analysis and thus the recyclability of the carrier material.

'Recycling is a complicated field,' says Gert-Dieter Werner. 'To come to grips with it, we have determined three short-term goals. These are the optimisation of existing materials, the development

'BMW is turning a still unused nuclear waste site into a recycling unit'

of more fully recyclable materials, and further experiments concerning new technologies required to combine and later separate recyclable materials. To reach this aim, BMW is currently converting the stillborn Wackersdorf nuclear waste disposal site into a pilot plant for vehicle recycling.' **Georg Kacher**

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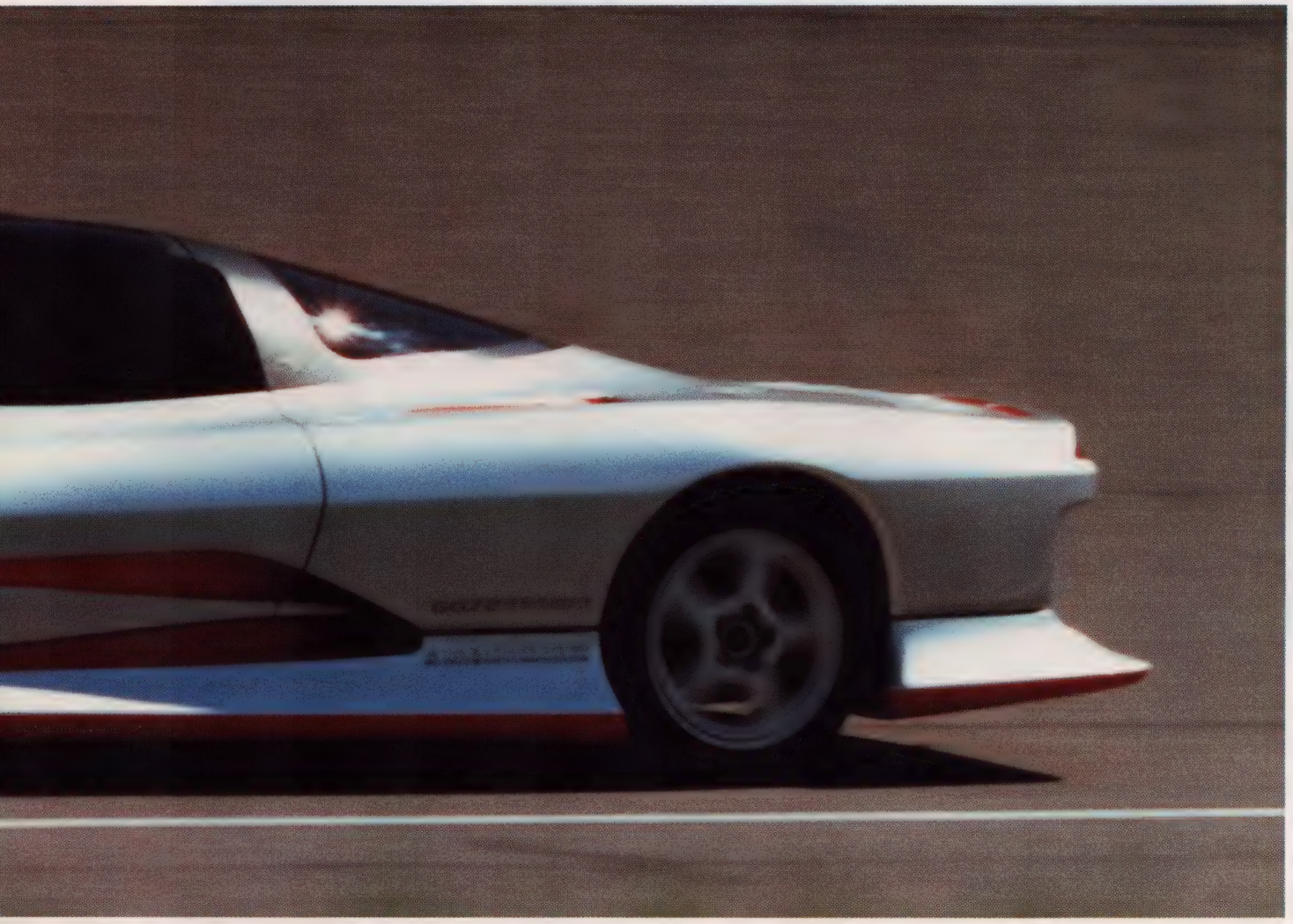

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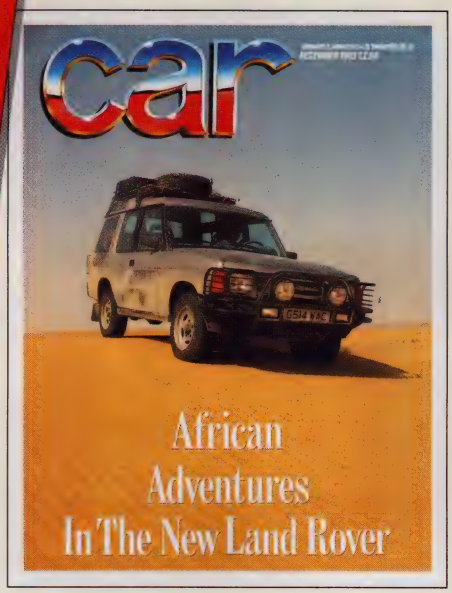

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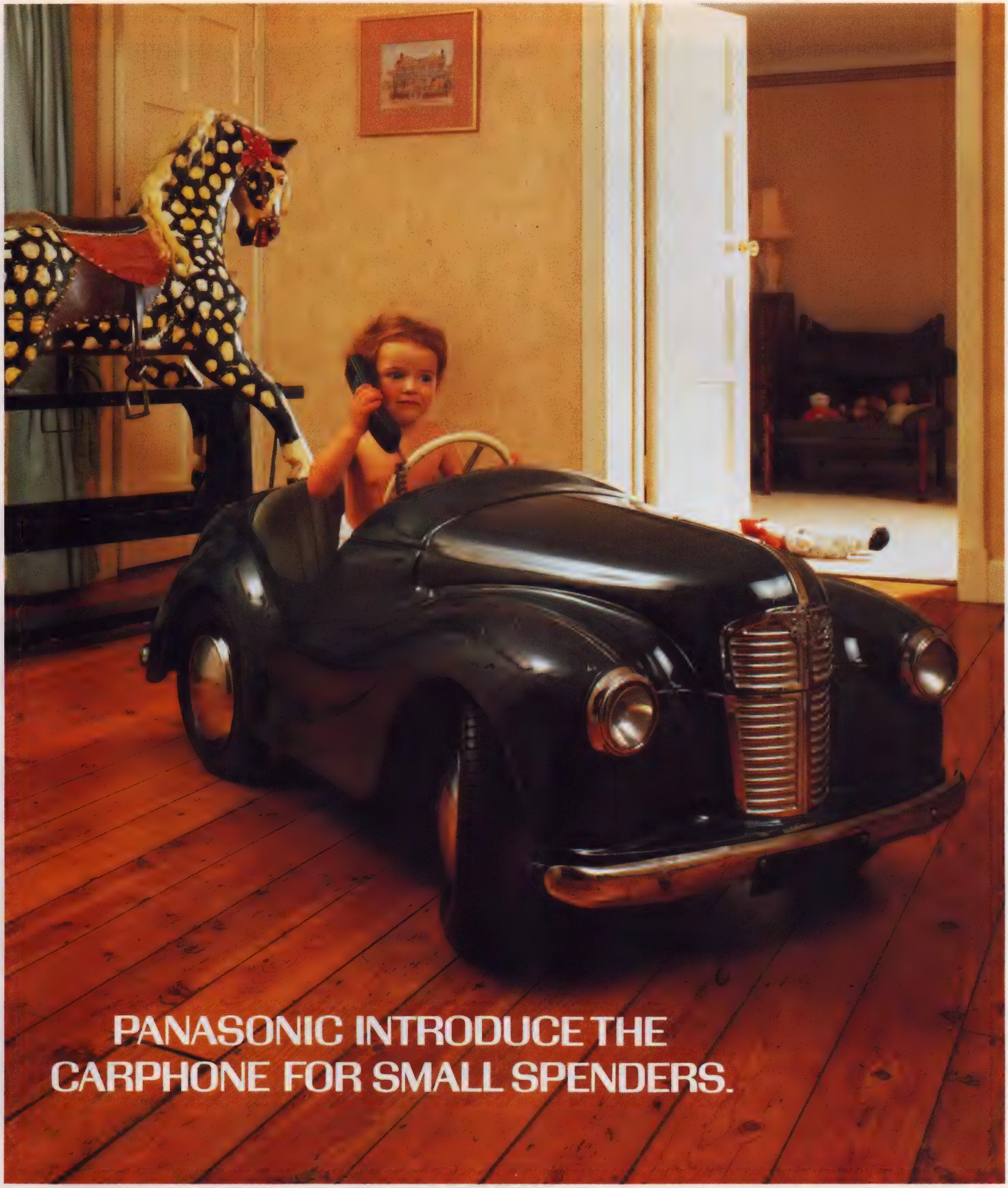

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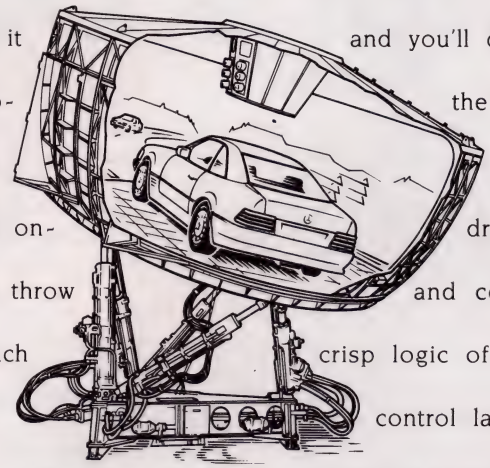

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'PROGRESS IN THE DESIGN of the car is not determined by the abilities and imaginations of the engineers who do the work; that is its tragedy. It is instead determined by the needs (real or supposed) expressed by us, customers; and that is ours.

That simple lament lay at the heart of the comment with which I closed a paper on the future of the car, which the Institution of Mechanical Engineers invited me to compose and present in 1975. If in 30 years the car did not still remain recognisably similar to the car as we then knew it, I declared, society would have failed the engineer; but if it were still recognisably similar in 60 years, the engineer would have failed society.

Why 30 and 60? I had discovered that progress in powered transport worked in 90-year cycles, which could be seen to be divisible into minor periods of 30 years. We are now just half way through the first 30 years since my paper.

It remains as apparent as ever that, so long as the motor manufacturers are in business to make money, and must compromise their investments in long-term idealism for the sake of short-term profit, the cars they make must be such cars as we shall readily buy – cars such as we are sure we want.

Alas, the buying public wants only what it knows. It does not know what is possible, and is very slow to understand and accept ideas that have only recently become feasible.

The public is, on the other hand, dangerously quick to superimpose new social pressures on existing practical requirements. Demands of this always rather febrile kind usually prove to have had political origins and support, but they usually lose their fizz after about 10 years, when the bored public turns away to endorse some other witch-hunt. Few people care as earnestly now as they did in 1968 about Los Angeles smog, or in 1973 about fuel consumption; nor will many still worry in 1999 about lead or the ozone layer. The effects of their worrying will all remain, however, on the world's statute-books.

Designers have to find their ways around a morass of legislation about crash safety, for instance, rules which cripple their initiative over bumpers, lamps, mirrors, switchgear, impact absorption, materials, structures, everything from the fundamental to the incidental. Had the public really cared about safety as much as they liked to claim, they would have accepted early seat-belt legislation proposals which would have made much of the other legislation unnecessary. While the law is always an obsolescent codification of yesterday's experience, tomorrow's car will be an inhibited embodiment of today's prejudice.

Accordingly, if I am to look forward 15 years and thus complete my first 30-year sub-cycle, I should be only slightly brave to forecast what is likely. If I were to forecast what will be apparent another 30 years later, that would be downright foolhardy.

In 2005 the car will still be what has always made it so precious, what some perceptive taxman once defined as the 'private car'. It is that privacy which enables the driver to go from door to door rather than from station to station, to choose his company or to choose to be alone. It is that same flexibility of use which will make offensive the thought of cobwebbing the world with any kind of adequate public-transport networks. Yet already the roads are crowded and cramped, and parking is so difficult that getting to the door is often either illegal or, which is worse, impossible.

Except in places enjoying the utmost grandeur of scale – Texas, perhaps, or Mongolia – cars will be required to be smaller. Luggage boots and frontal overhangs will diminish: materials, science and structural engineering should have found other ways of accommodating the accidental shunt. The spare wheel should be disappearing: the tyre carcass and wheelrim made in one integrated piece and filled with pneumatic mousse, already under development, should be a production reality increasing in popularity and diminishing in diameter.

This reduction in unsprung mass will aid the suspension engineer faced with the difficult task of making a small car ride as smoothly as a big one. Electronic control of pneumatic suspension should be the general means of accomplishing this, but only in rare and dubious cases will it be active suspension; highly advanced versions of today's latest reactive systems will be the rule, still passive but perhaps good enough.

Airfoils or wings should go as the new body shape begins to show. With less demand for useless interior space (interior width or 'elbow-room' is already excessive in most cars today), the body will look very low and wide at the front, rather tall and narrow at the rear, as it begins to assume the structurally ideal and aerodynamically attractive shape of a well-rounded tetrahedron.

The big question in 2005 should be the engine. It will still be an internal combustion engine; electrification will still be folly. Electricity is not a source of power but merely a form of transmission, and in 15 years' time it will still be an inefficient one. By then the internal combustion engine may be very efficient indeed, combining the best features of spark and compression-ignition engines.

To enjoy the advantages of a diesel without the gross handicaps of a diesel, it will doubtless be a pressure-charged uniflow two-stroke with variable timing and direct injection of preheated fuel, so that knock will be impossible, emissions easily controllable, flexibility of performance impeccable.

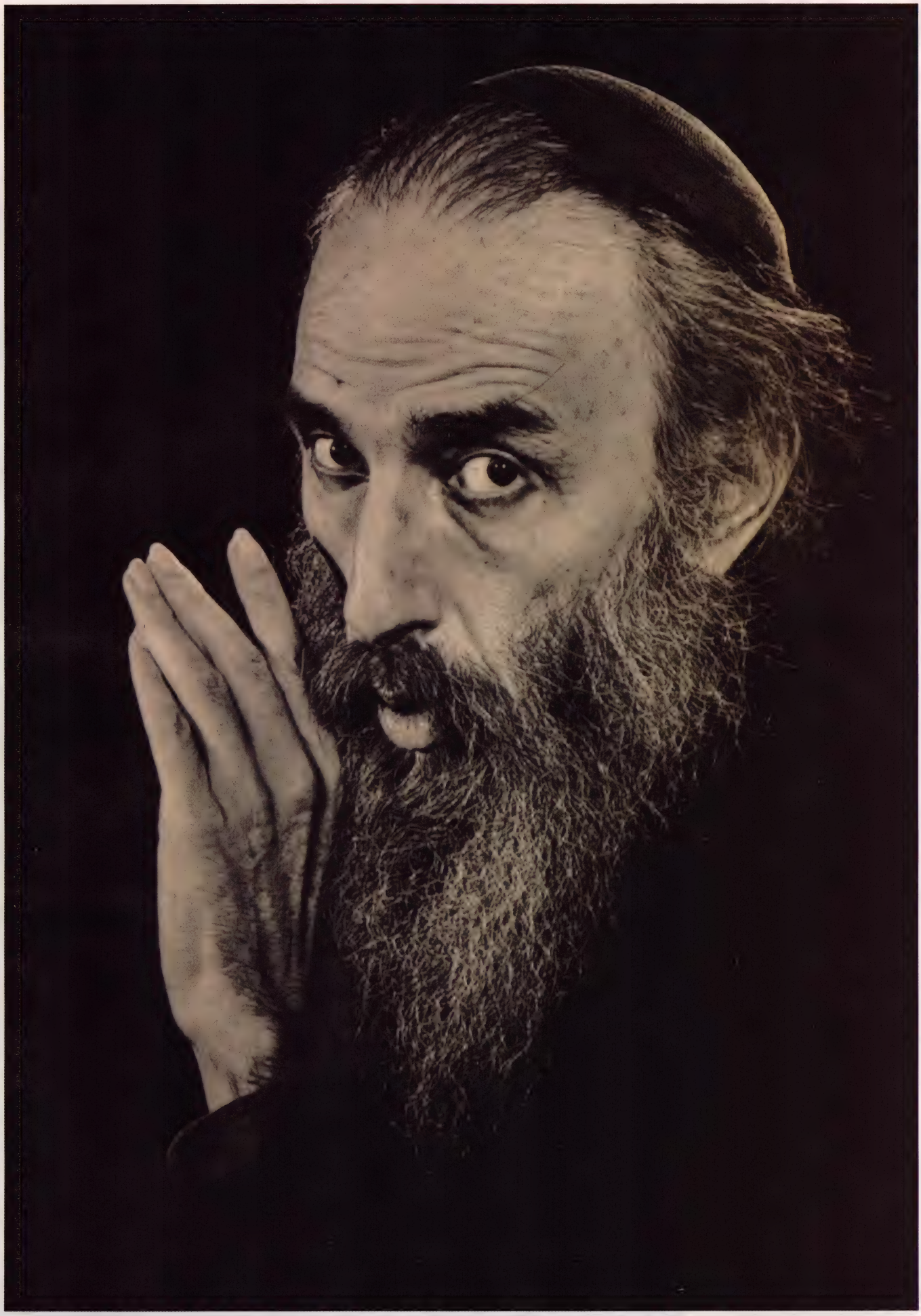
Given another 30 years, such an engine may also be exploiting variable compression ratio, and I would hope that by then its fuel will be that in which the world's crust is richest, lovely clean energetic methane. It should be rivalled, then, by electricity: all the plethora of new motors invented or investigated in the 1950s (best known so far is the linear motor) should have advanced enough to be practical. Already today there are motors the size of a microchip; by 2035 there should be motors light enough to drive the rims of centreless wheels.

All the wheels will be powered (and perhaps braked by the same system), and all will be steered; but there will not necessarily be four of them. They could number five or six, or just three; but each should be totally enclosed in its own housing, a plenum chamber kept evacuated of air. High-vacuum downforce generated at all speeds and even on poor surfaces is better than the low-vacuum kind generated only at high speeds and on smooth roads by today's racers; the private car of 2035 should grip and ride superbly.

Mere handling should have been transcended. All remaining controls will be fully powered, but the steering wheel (originally needed as a convenient medium for muscular effort) should have gone, and transmission management should be totally automatic. The driver need exercise neither skill nor strength.

Thirty years after that? Forget it. Unless G–d bowls us another googly and a grossly overgrown population is drastically reduced, what passes for government in 2065 will have exploited the communications revolution to keep most of us at home, linked to our work electronically. What every government likes is a docile, placid population devoid of wanderlust or any other form of curiosity. Forget your battery cars then; like so many zero-range chickens, we shall be battery people.'

Photograph by Stuart Redler



Living with an Electric Car

George Bennett spends two days in Paris driving an electric Peugeot 205

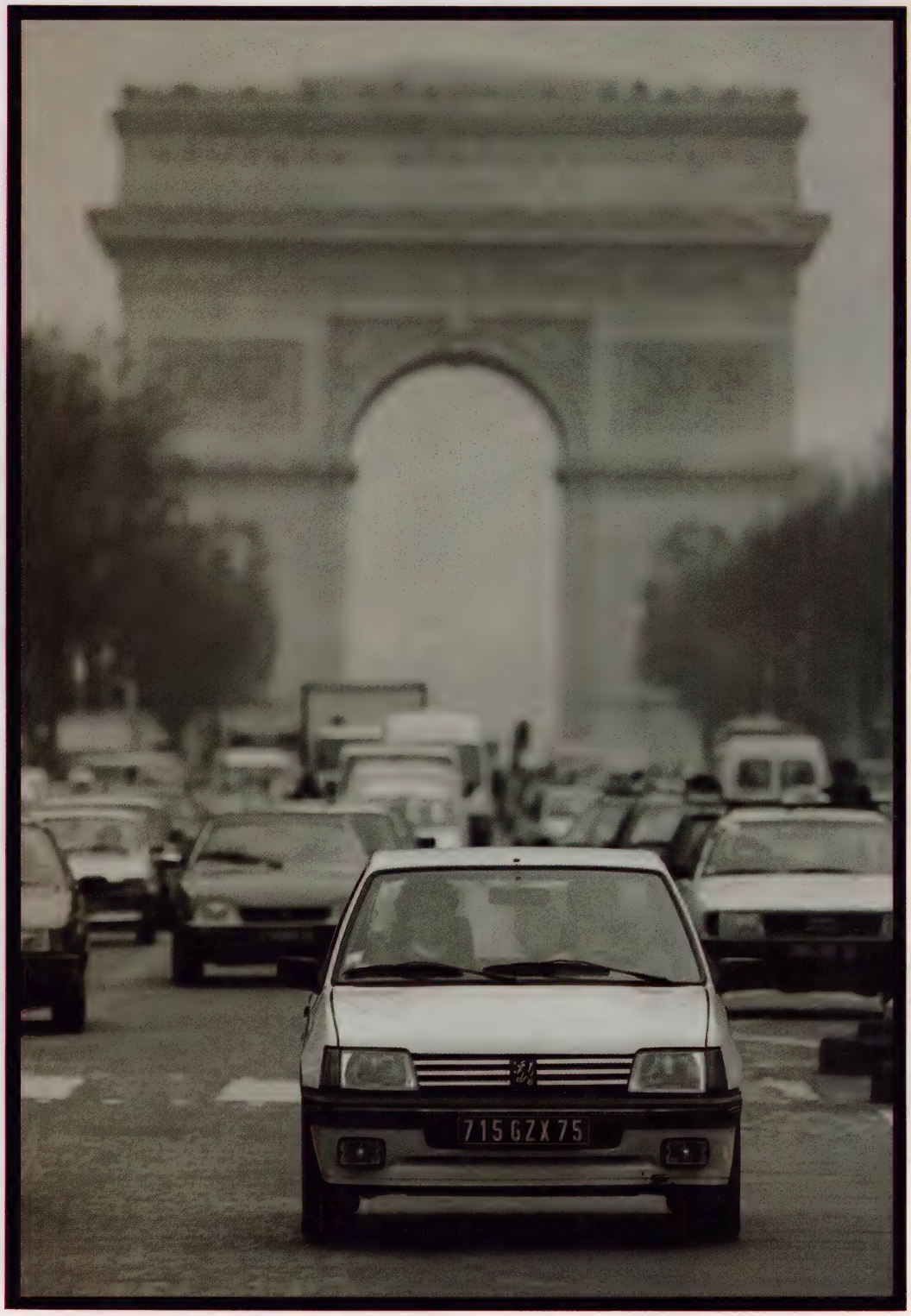
Photographs by Andy Christodolo

IT'S IN HEAVY TRAFFIC that the electric Peugeot becomes entertaining. The car is carrying *Vehicule electrique* stickers which make people look; then they wind their windows down and listen: when we're stationary, there's no noise – at all. Other drivers keep staring; most of them grin. For the car's occupants there's no vibration, either, because at rest the electric engine doesn't tick over, and it takes a while before a driver new to electric power develops full confidence that the motor will come alive when the accelerator is pressed.

On the move there is almost no noise from the motor; from the outside the loudest sound is from the tyres, and against the background of ordinary traffic, the car is effectively silent. We start imagining what a big city would be like if all the traffic were as quiet.

The idea is almost too good to be true: in a few years we could all be whizzing about town in silent, pollution-free cars that would leave our cities as clean as our consciences. That's the theory, at least. To see whether it would work in practice, we're spending a couple of days in Paris with a prototype electric Peugeot 205.

Most major car makers are looking at some form of electric propulsion, but PSA – owner of



Electric Peugeot 205 keeps up with traffic – it's more at home in the city centre than on open roads

Writer Bennett and friend Sara de Pauley prove there's plenty of luggage space in the electric car

Peugeot and Citroen – is testing electric cars in everyday use, and expects to offer them for sale to the general public within 18 months to two years.

The electric 205 hatchback is unrecognisably more sophisticated than most people's milk-float image of electric vehicles. Indeed, until you lift the bonnet or switch on, it's unrecognisable as anything but an ordinary 205. Although there are 12 six-volt batteries, weighing a total of 282kg, they're all stashed under the bonnet, leaving the passenger and luggage space untouched. The motor itself is mounted under the batteries, between the front wheels, which it drives through reduction gears. There's no gearbox.

Making the electric Peugeot as conventional as possible – apart from the engine – was deliberate, as Jean Helmer, general manager of PSA's automobile division, explains: 'We are trying to reduce the extra cost of electric power as much as possible, so we designed it to use the maximum number of standard parts, and to use the same production line as conventional versions.

'We expect that we could reduce the extra cost of buying an electric car to a premium of £3000 over an equivalent petrol car; if we could sell 50,000 a year, it would be possible to get the price to the same level, or even cheaper, than a petrol version.' The company is already fitting electric motors as an option in its range of one-tonne Citroen C25 and Peugeot J5 vans, but they are a primitive first step towards electric propulsion compared with the Peugeot 205 that represents 'phase two'.

There are two main advances with PSA's electric car. Most important is the high-tech control system used in the 205. The vans use an ordinary gearbox, which allows a cheap and relatively primitive control system for the motor. The 205, on the other hand, has complex electronic controls (also under the bonnet) which include two 'choppers' to vary the current to the motor very accurately, giving smooth control through the accelerator pedal.

The motor and its control system works in reverse as a generator while the car is braking, feeding power back into the batteries. The brake pedal has a flap hinged onto it which actuates the 'regenerative' braking – pressing it lightly switches the chopper and motor into generating mode. Press harder, and the standard disc brakes start working.

'Regen' braking is very important in extending the range of the car. In our two days of driving, a test computer monitor shows that we restore 16 percent of the battery's power on the first day (when we do a lot of start/slow-down in traffic) and 13 percent the second day, when we spend more time at constant cruising speed in the suburbs.

Another very important aspect of the 205's control system is that it regulates the battery recharging. There's no need for a separate unit. The car has its own retractable cable (just like a vacuum-cleaner) which can be plugged into any household socket to give a complete recharge in eight hours. There's a second recharge point as an alternative, through which the batteries can be restored in only three hours, using a special high-power supply. PSA talks about plug-in recharging at parking meters.

The other advance in the 205 is the use of nickel-cadmium batteries which give twice as much power for a given weight as the conventional lead-acid types used in the one-tonne vans. The disadvantage is that they are very expensive, and will remain so until mass production lowers the price.

PSA's 15 prototypes are on long-term trials with utility companies in France and Belgium, while staff at the company's electric power research centre at Velizy, near Versailles, use them for daily commuting to work. Our aim is

to spend a couple of days running typical city centre errands, so as soon as we pick up our test car at Velizy, we head into the centre of Paris, where we have enlisted the help of a Parisian friend, Sara de Pauley, to take us and the car on a shopping expedition.

Starting the car takes a lot of getting used to. Switching on produces no noise, and nothing happens until you press the accelerator. Then the car moves off smoothly with a slight but unmistakably electric whine. We reach 50mph – maximum speed for this particular car, though other test cars are geared to 60 – in a leisurely manner, but it's not unacceptably slow.

On the otherwise conventional dash there's a digital display to show how much energy (measured in Amp-hours) remains in the batteries. It starts with a full charge of 200Ah on the clock, and it's disconcerting to find it dropping rapidly to 180 as we bowl along the dual carriageway. But as we drop down a long hill into Billancourt, I touch the brake pedal lightly to activate the regen braking – leaving the normal brakes alone – and am rewarded with the sight of the clock returning to 183Ah by the time we reach the bottom.

I soon get used to anticipating hold-ups well in advance, which gives time to use the regen brakes. They are less effective, as brakes, than the discs, and need more distance, but they allow the momentum to benefit the batteries. It makes for a relaxed style of driving, even in Paris.

In heavy traffic along the Avenue de la Grande Armee, and around the Arc de Triomphe, the electric car is fully competitive with other traffic; you don't notice the low top speed, and the 205's acceleration to 20mph is little worse than it would be if the car had a small petrol engine.

Passers-by notice the car only by its temporary stickers. Otherwise it looks like a standard 205

When we meet Sara at her apartment near the Place Vendome we realise one major drawback of owning an electric vehicle – reaching your household socket if your flat is on the first floor, or above. Even if you could find a parking space right outside, it would hardly be practical to trail a cable across the pavement and up the outside of the building.

We set off for a spot of shopping in a crowded local vegetable market. Here's the second drawback: the car is so quiet that people don't hear it coming, and don't get out of the way. One woman and baby look right at us as we approach. but clearly don't register that we're moving, since there's no noise, and continue to walk across the road. Emergency stop, using all the brakes.

Charging is simple: just plug in car's own retractable cable

The problem is worse when I try to manoeuvre the car for photographs, because there's no tick-over noise from the engine, so passers-by don't expect it to move. When we remove the *Vehicule electrique* stickers, the white 205 is totally unremarkable, and the problem is worse. The horn is a necessary accessory.

So is power steering, not yet fitted. The weight of batteries and motor under the bonnet is nearly twice that of a conventional diesel engine in the 205, so the electric car has the front suspension from the larger 405 to cope with it, but the massive front end makes the steering very heavy. PSA is about to try electric power steering, but disarmingly admits it doesn't know yet how much power that will rob from the batteries.

Ancillary electrics, such as lights, indicators and heater fan, run off a small auxiliary battery fed from the main traction pack. The occupants are kept warm by a diesel-burning heater as used in truck cabs at night.

By the time we reach our next stop, to pick up groceries at a supermarket, I'm gaining confidence in the electric motor's abilities, although the car is still pulling a few surprises. For example, it feels like an automatic, but when we stop on slight slopes in traffic, the transmission doesn't hold the car as it would in a conventional auto. As soon as the car stops, the motor stops, and there's nothing to prevent the car rolling backwards. You can, however, hold the car by pressing very lightly on the accelerator pedal so that the motor has enough current to be on the point of turning – it's an example of how sensitive the accelerator is. Reversing is very simple. Stop, press a button on

Discussing shopping and cars in Jouy en Josas, in Paris suburbs

the dash, and press the pedal.

At the end of the afternoon we return to PSA's headquarters in the city centre and line up the car next to a wall socket in the company's underground car park. It takes no time to plug in the car and press another button on the dash to start the charging process. It also starts an unpleasant and surprisingly noisy buzzing from under the bonnet, but PSA engineers say that, too, will be fixed by altering the charging frequency.

Next morning, the 205 is again ready to roll – 200Ah back on the clock. We do a few runs up and down the Avenue de la Grande Armee. I'm now doing U-turns across four lanes of Parisian traffic with aplomb. I'm ready for the final test: the *Peripherique* Paris ring-road. Here the electric motor isn't up to battling in the fast lanes, so most of the time we stick with the trucks in the slow lanes, where the *vehicule electrique* manages quite well.

We leave Paris on the N118 towards Velizy, and that long hill that gave the batteries so much power on the way in, slows the car down to barely 25mph. By the time we reach level running, the meter is showing 70Ah – it definitely runs down faster than when we're in traffic where, unlike an ordinary car, no 'fuel' is used when the car is stationary.

In theory, the car should begin to run slower, to conserve the batteries, once the charge drops to 40Ah, but there's no sign of it as we continue meandering around suburban villages, watching the meter drop to below 20. Only when it's down to 10Ah does the car seem to slow down, and the charge warning light comes on at 5Ah. In fact by the time we return to the research centre the gauge has been showing zero for a couple of kilometres. Apparently, the 200Ah is only an average for the battery pack; we happen to have a good one, which has given us a little extra range. Even so, we have covered only 72.5km (45 miles), rather short of the electric car's claimed maximum. We've averaged 19.5mph, including the early session in central Paris.

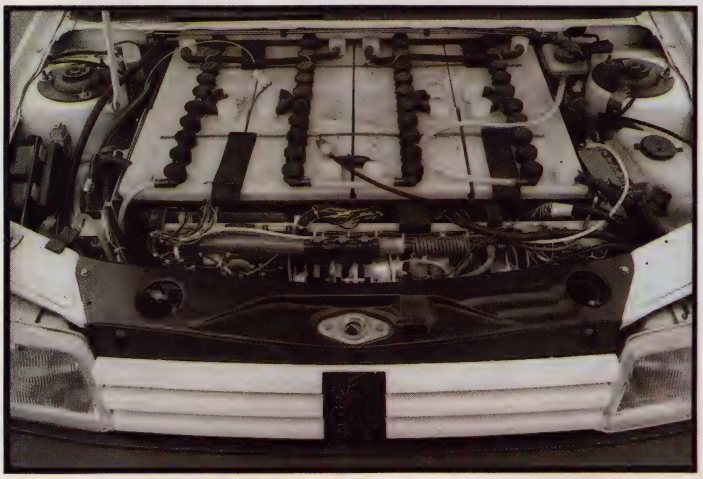
Overall, the electric 205 is a practical proposition, particularly in the city, where it keeps up well with traffic, and gives all the usual benefits of a small nippy hatchback. Out of town you notice the lack of performance more, though it's quite an acceptable commuter.

There is the serious practical problem of finding a parking space near a power socket, but that could be overcome, and there is a lot of work still to do in refining the car to make the brakes and steering lighter. It remains a specialist machine, a second car for city and suburban dwellers, with a safe range nearer 50 miles than the claimed 75. But for most daily use, that's plenty.

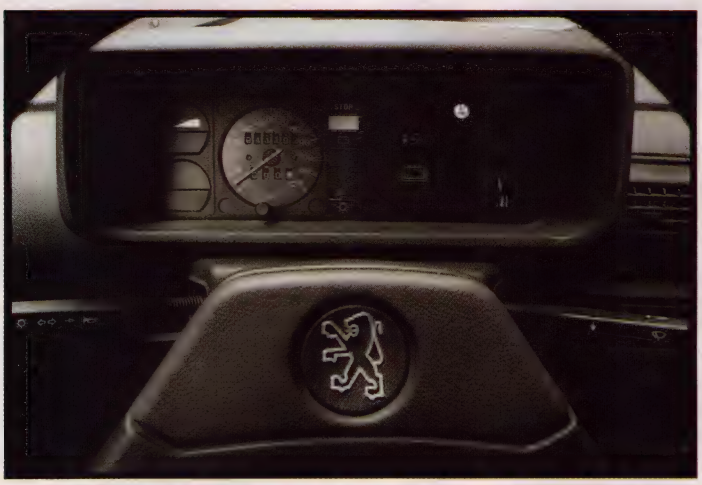
But the 205 itself is only phase two in a long-term programme, says Jean Helmer, who has overall responsibility for the direction of future research: 'Phase three is a hybrid design, using a multi-fuel turbine engine and an electric motor. It would have batteries to power the motor, recharged by the turbine, but they could also be recharged outside, like the 205.

'The hybrid will be able to do 130km/h (80mph) between cities, and there will be no limit to its range. We are developing a constant-speed turbine rather than a diesel for the hybrid because it will be three times more efficient. First prototypes will be ready in 1993.'

Meanwhile, PSA is pressing ahead with the electric 205 as an intermediate step: 'We are working with our suppliers to reduce the cost of the components and batteries, and by 1994-5 we could arrive at an annual production of 50,000 cars, two percent of our total production,' says Helmer. It's a bullish picture.

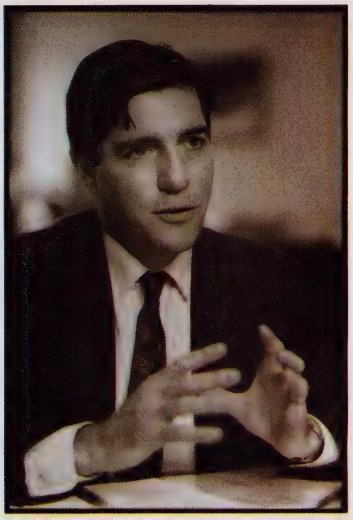


Battery pack, control system (front) and motor, all under bonnet



Amp-hour meter shows 150Ah of energy remaining in battery

Electric motor makes no sound when stationary; pedestrians are surprised when it starts to move



PSA's Jean Helmer

THE FATE OF THE SUPERC

ENVIRONMENTAL PRESSURES needn't mean that we will all be driving boring cars a decade from now. Even supercars will survive to 2000, and well beyond, according to Mike Kimberley, managing director of Lotus, Britain's largest builder of high performance sports cars: 'There's still a lot of fun to be had with cars,' he says cheerfully. 'There will always be drivers who want something distinctive.'

But the supercar will change. It won't be powered by a massive and profligate 12-cylinder engine; top speed won't be important, though electrifying acceleration and stunning looks will be. The difference is that the next generation of supercars could be returning at least 40mpg – two or three times better than you'd expect from a current Ferrari or Lamborghini. Not that your average supercar customer cares about the price of fuel, but social pressure may oblige even the rich to care about the pollution that comes from heavy consumption.

'There will be a lot of social pressures on cars,' Kimberley says, 'particularly in markets like California and Tokyo. Energy consumption and ecological considerations are important, and we have to face up to them. Yes, you can have high performance, but the car has to be environmentally clean. Acceleration will still be important, but a high top speed may not be acceptable, and people will ask themselves: "Why do I need a car that does 150mph?".'

Kimberley believes the market for very high performance cars will remain stable for another five years or so, and then start to decline, because of legislative restrictions and, maybe, public opinion. But supercars won't die: 'People will always want an individual car – you'll never, ever get away from that – but there will be a redefinition of what a supercar is; it won't be based on speed, but on being different from the rest.'

Originally, Lotus's new supercar (codenamed M300, and likely to go on sale in the mid-1990s) was to have had a powerful V8 or V12 engine. But, says Kimberley: 'We redefined the project about a year ago. One reason, frankly, was that there has been a plethora of new supercars, but the other reason was to address green issues. We are looking at the motive power source in an ecological way; we have changed the specification of the car radically.'

Kimberley chooses his words with care; he doesn't talk about future engines, but of 'motive power sources'. He won't go into details, but Lotus is known to be working on a hybrid design using a light and efficient turbocharged four-cylinder petrol engine for country use and an electric motor for the city. Even without the help of the engine, the electric motor should be able to propel the M300 from 0-60mph in less than nine seconds. There will be no restriction on range, since the engine will recharge the batteries on longer runs.

'Producing just another supercar is no good,' Kimberley explains. 'With our new car we're looking at a different vehicle from the ground up. You want a car that will respond in just the way that the driver anticipates. Active suspension and four-wheel steering (controlled by microchips and an array of sensors), combined with a variable torque split (between the – possibly four – driving wheels) will improve cornering. We should be able to achieve the responsiveness of a formula one car, so the driver will be better able to avoid accidents and steer around pedestrians, for example.'

That will make cars more responsive and fun for the driver, and increase safety: 'In the future, standards of ride and handling may be established by legislation, to improve primary safety, as distinct from secondary safety features such as crash protection.

'Little things like anti-noise technology can bring benefits in any car.' Lotus is already working on a system which generates a sound signal to cancel out noise from the engine, tyres and other major noise sources. This reduces driver fatigue and thus promotes safety, but there is a less obvious pay-off, as Kimberley explains.

If engineers can smother unwanted noise with a cancelling signal, they don't have to worry so much about making the car itself quieter in the first place. So engines won't have to be so massive, to reduce vibration, body panels will not have to be so hefty and there will be less sound deadening: 'That allows us to take mass out of a car, which saves raw materials and makes the vehicle lighter and more efficient,' says Kimberley. Anti-noise and computer-controlled handling will be features of the M300.

Kimberley expects niche markets for specialist cars to become increasingly hard-fought. The established supercar makers will find heavy competition from car giants – particularly in Japan – making image-building high-performance flagships of an ability to challenge existing names. What they won't have is a powerful brand image – such as Ferrari, Porsche or Lotus enjoy – that takes years to develop.

The traditional way to establish a sporting brand name is to go racing, but surely the days of such profligate activities as formula one are numbered? Kimberley – not surprisingly, since Lotus has its own F1 team – doesn't think so: 'I don't see disapproval for racing in the foreseeable future. A lot of technology comes out of it, and besides, the human race has got where it is by being competitive.'

Another company which has long stressed the importance of motor racing – and is about to re-enter formula one after a three-year absence – is Porsche. Like Lotus, Porsche is one of the few sports car manufacturers renowned for its high technology. And, as with Lotus, it earns a tidy sum by undertaking engineering consultancy work for certain mass makers.

Illustration by Willie Ryan

'Top speed won't be important, though looks and acceleration will be. But supercars will be capable of 40mpg'

Porsche's new chairman, Arno Bohn, says the next-generation Porsches will offer more performance, and give more driving pleasure. But, he insists, they will also be more environmentally friendly, featuring much better fuel economy. They are also likely to be partly recyclable: 'Long term, I'm talking about cars that you can take apart at the end of their lives, and re-use the bits. I'd like to make sure we waste no raw materials.' Bohn is also keen to reduce weight, thus increasing performance and helping fuel economy.

Turn to the subject of future engines, and Bohn is especially enlightening. 'Short term, we'll have much more frugal petrol engines. But long term, I see solar power playing a role.' He even talks about future Porsches being powered by rape seed oil. 'Growing the rape would require as much carbon dioxide as the combustion process sets free. It could be an ideal solution.'

Neither Bohn nor Kimberley see any reason for performance car makers to be defensive; whether they're right depends on how well they improve fuel consumption without sacrificing performance, and how distinctive they can make the new breed of green supercars. **George Bennett**

Lotus MD, Mike Kimberley

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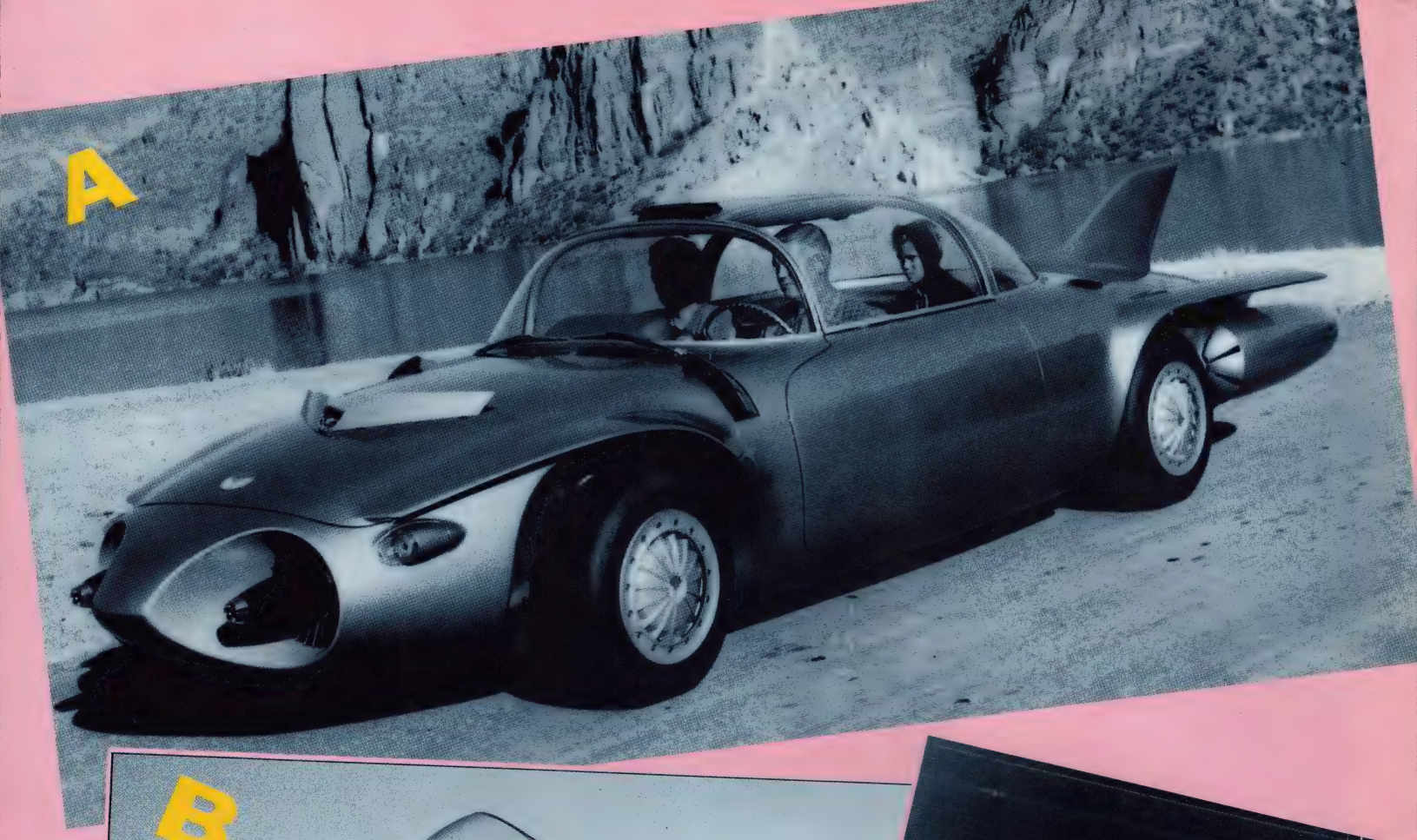
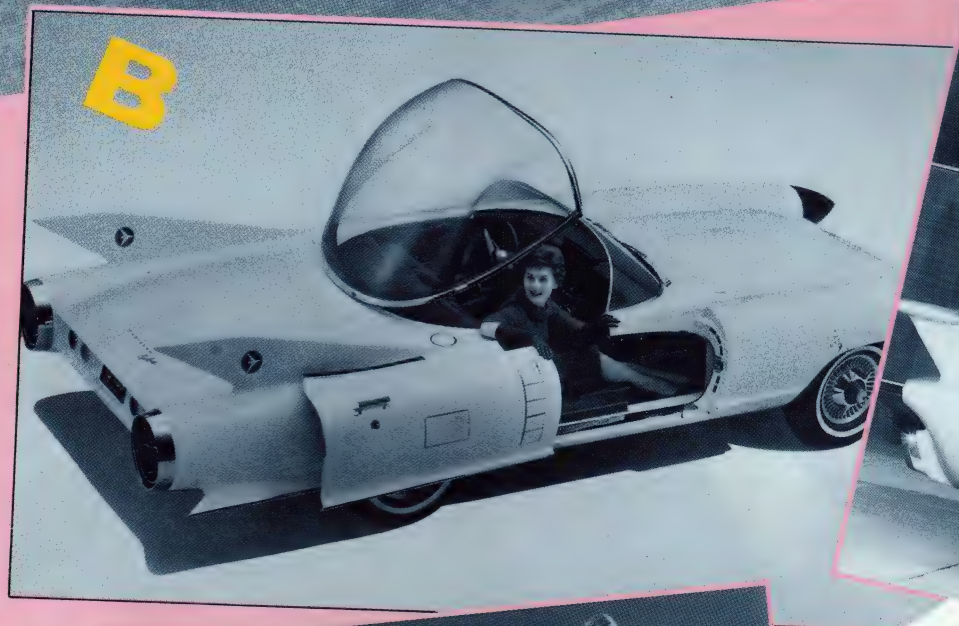
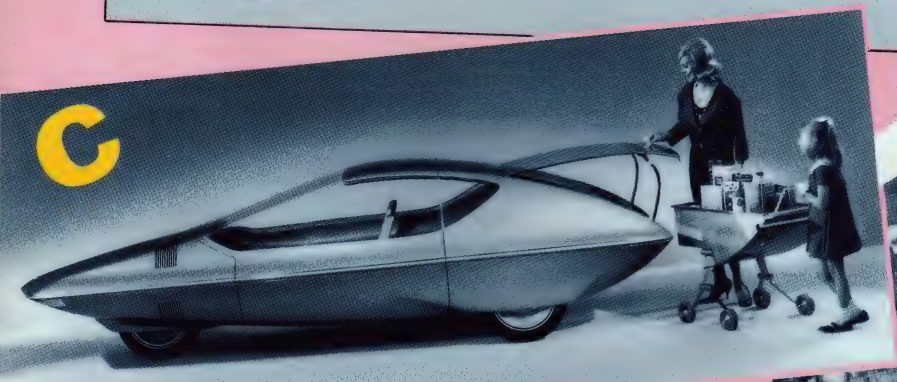
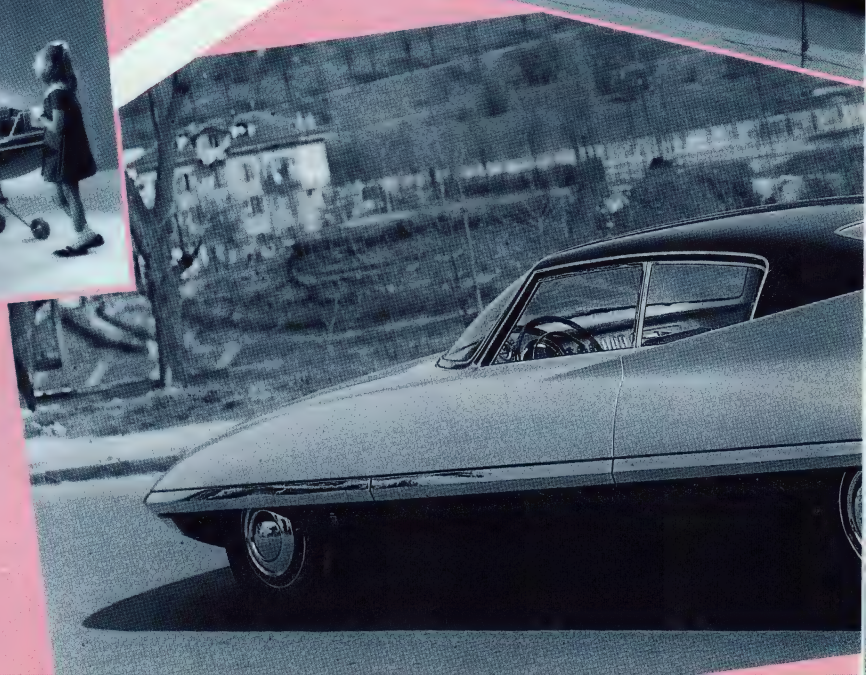






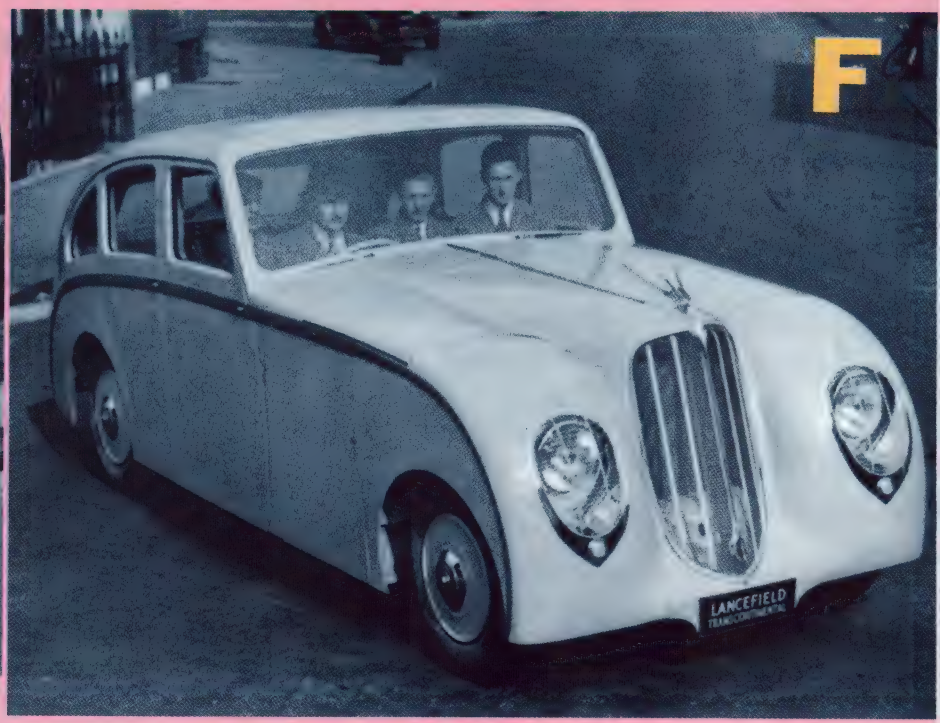


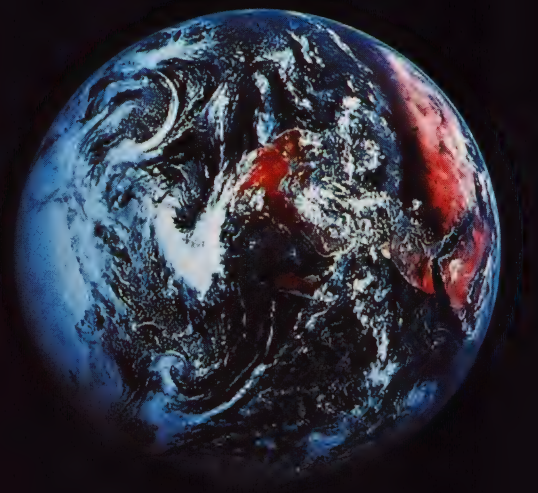
Designed by General Motor's Harley Earl, the '54 Firebird (A) was intended to use a gas turbine engine, though it didn't run. Aircraft-style detailing abounded, whether it was useful or not. The '59 Cadillac Cyclone (B) looked like a couple of fused missiles. The Cyclone used standard running gear, but novelties included short-range radar, sliding doors and a bubble top. GM's '64 Runabout (C) was an urban car complete with built-in shopping carts. The Runabout's front wheel swivelled through a full 180 degrees for easy parking

Future past

DAFT DESIGNS THAT DIDN'T MAKE IT • RICHARD BREMNER

Ghia Gilda (D) of 1955 was an early study in aerodynamics, producing this huge wedge with its collosal fins. The Gilda lives on in the Henry Ford museum in Michigan. Chrysler Turboflite (E) of 1961 was powered by a gas turbine engine and actually ran. The bubble top automatically raised when a door was opened, and the spoiler swivelled to double as an airbrake. The car was built by Ghia of Turin. Britain's Lancefield Transcontinental Hudson (F) featured four abreast seating, though it looks a bit of a crush. Note the Lancefield's curvaceous flanks





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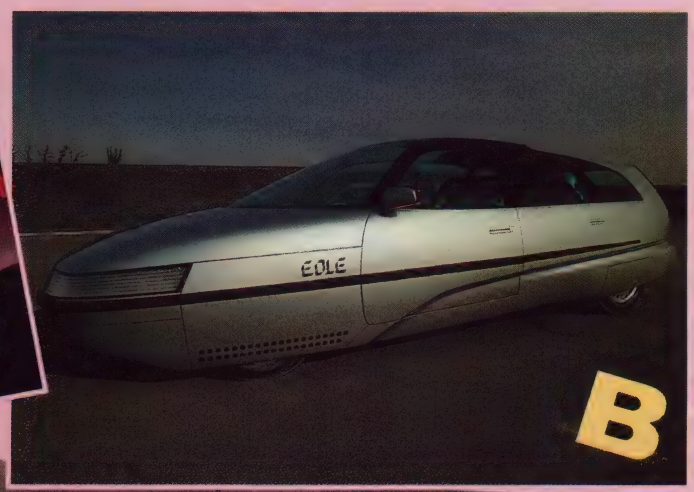
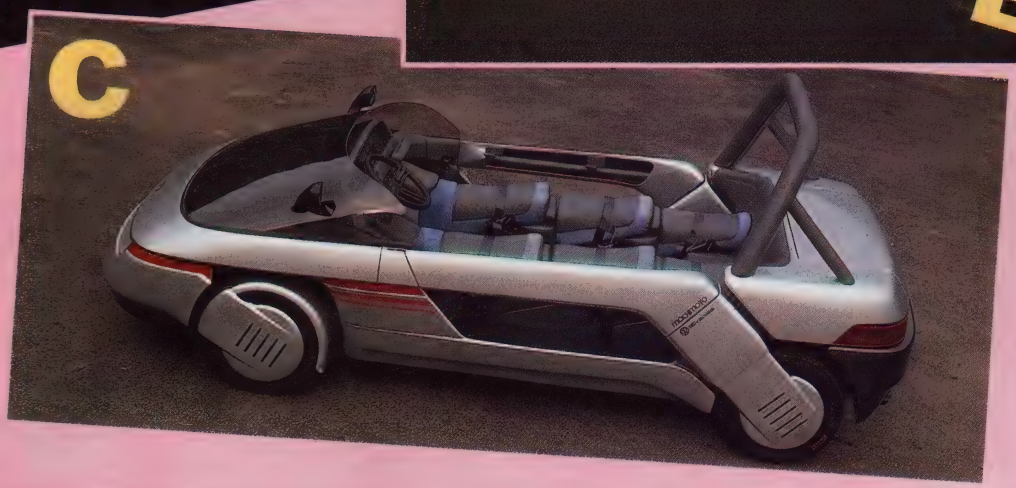
Future Past





1975 Ford Coins (A) had seats, central driving position and single rear door. 1985 Eole by Citroen (B) looked more like wind-eroded rock than a car. ItalDesign Machimoto (C) of '86 combined car mechanicals with seating of a motorbike

HISTORY REPEATS ITSELF

Skoda has been busy rewriting the history books over the past 20 years. And with the Favorit 136L winning on its first RAC outing, there's every reason to expect history to go on repeating itself in the future.

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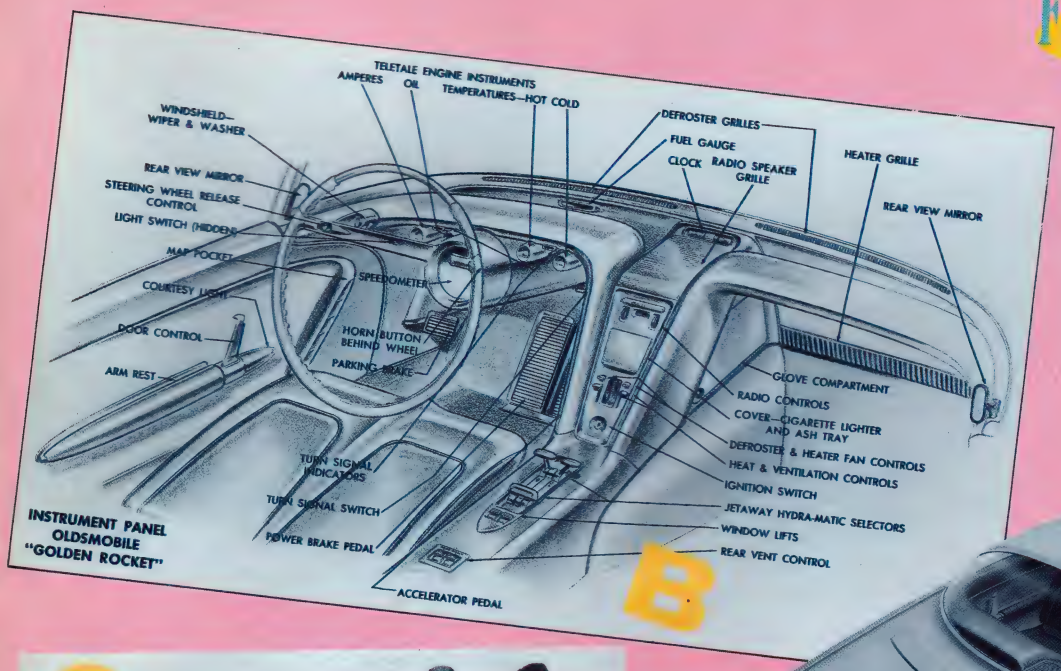
Future Past

The dawn of the space age brought on plenty of four-wheeled rocket fantasies such as the Oldsmobile Golden Rocket (A, B) of 1956. Novelties included seats and roof sections that rose three inches when the door was opened. Note rocket-shape armrests. Pininfarina Prototype X, 1960 (C) had its wheels arranged in a diamond formation. It was seriously tested before the idea was abandoned



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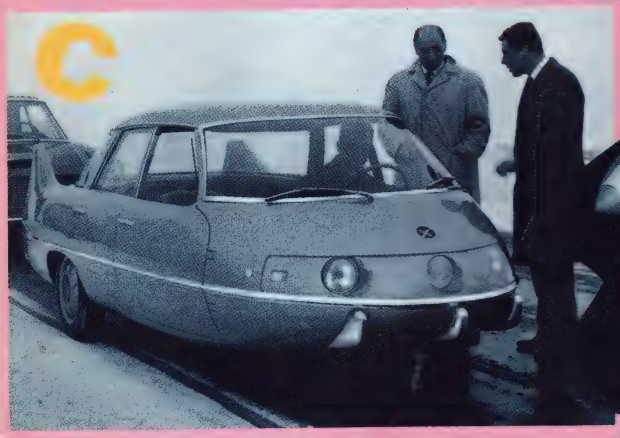
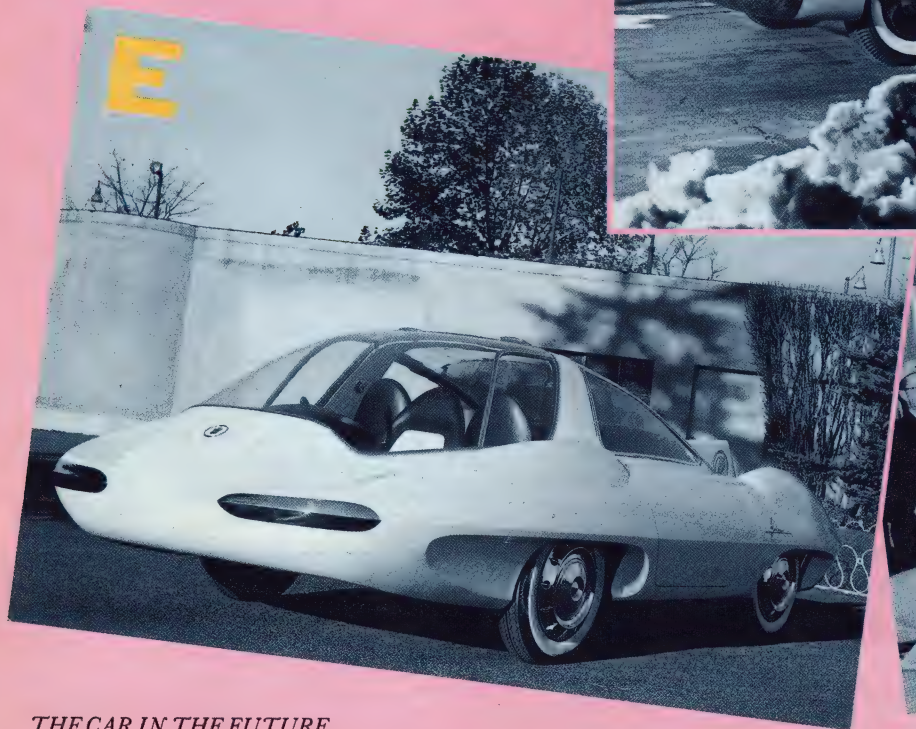


If the Lincoln Futura '54, (D) looks a little familiar, it's because it was the basis of the Batmobile, the prototype modified for the TV series. Ghia Selene Seconda '60, (E) had a central driving position and rear facing seats for passengers who could watch TV. These sheepish men (F) are General Motors stylists, searching inspiration from the airwaves. Note the space rocket on the cake



DOG

Richard Bremner on the C5, Sinclair's heroic failure

INVENTORS HAVE VISIONS. That's what fires them to take to the shed at the bottom of the garden and furtle away, often uselessly, for years. Not that the electrically powered Sinclair C5 was conceived in a shed, but it just had that ring about it. Instead, it came from the high-tech world of Sir Clive Sinclair, purveyor of digital watches, computers and calculators.

The C5 was a breakthrough, too – mostly of nerve. If it had come from a crackpot inventor with wild hair, staring eyes and a white coat, people would have laughed out loud. Looking like a futuristic bath-chair, the C5 was essentially a recumbent trike – complete with chain and pedals – shrouded in polypropylene plastic and powered by a 12-volt battery and a washing-machine motor.

This was a new concept in motoring, though that term was a little generous, perhaps, because the battery had the staying power of snow in summertime. True, you motored for some of the time, but for much of it you pedalled, especially if you were ambitious enough to attempt a double-digit mileage in one hit. If the battery survived seven or eight miles, it was doing well. Sinclair claimed a range of 20.

Yet the ice-white trike wasn't completely crude in its engineering. It had a backbone chassis engineered by Lotus, and a clever location for the steering gear. Its shape was honed in the wind tunnel and its plastic body was said to be the largest polypropylene moulding in production in the world. Yet despite all this, it had flaws beyond the fact that its range could be embarrassed by any decent long-distance runner.

Most of these stemmed from efforts to keep the price low. Among the items Sinclair considered superfluous were brakes on all three wheels, suspension and a roof. The will-they-won't-they nature of the anchors came close to being the most worrisome feature of the little white bug. The rear brakes, which operated solely on the offside back wheel, had a habit of locking, while the front brake didn't lock, it just gave a good impression of being defective instead.

More severe difficulties might be encountered on rough roads. The C5's narrowness and less than mercurial advance meant that you tended to crawl along in the gutter, which was all right until drains or pot-holes loomed. When the C5 fell into these, butt and spine were in for a pounding, and so was your heart if the jerk redirected the trike into the traffic. The problem was the suspension, or rather the total absence of it.

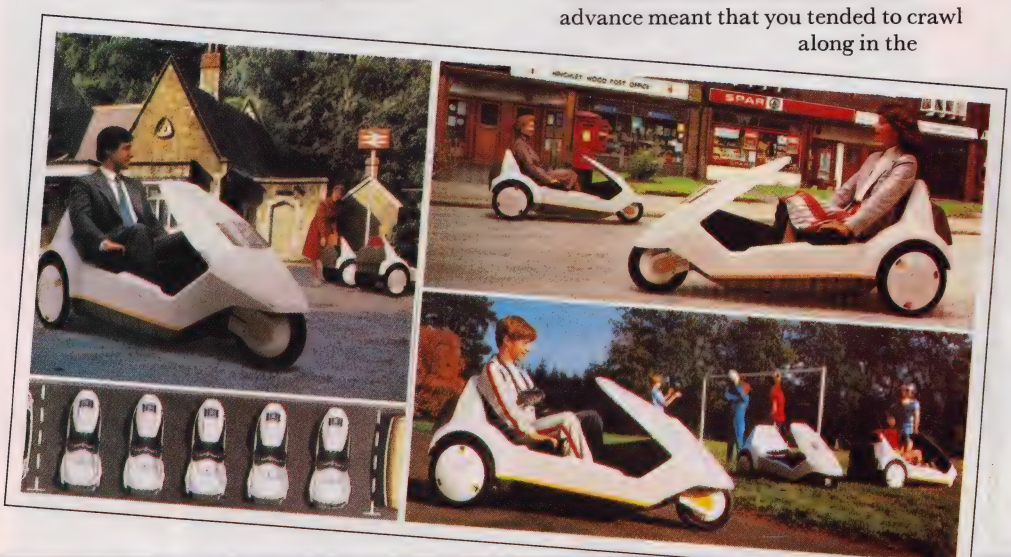
So how did a vehicle this flawed make it onto the road? By steering straight through a legal loophole. A couple of years before C5s turned up in their cardboard boxes – yes, that's how they were delivered – the government modified legislation to allow electric cycles with fewer than four wheels, under 60kg and with a top speed of no more than 15mph to take to the street without tax, insurance, or an MoT. And owners, who could be as young as 14, didn't need to wear a helmet, either.

The C5 was an opportunistic attempt to cash in on this. Not that the trike was completely without merit. Its simplicity kept the price down and it was easy to drive, too. Steering was a doddle, and so was parking, with a 19ft turning circle in a machine a fifth the size of a car.

Other merits included its low noise, the fact that it didn't pollute and that you could easily drag the beast into your house for storage at night if you didn't have a garage. Prolonged use would reveal more subtle drawback, mind. Hard cornering, even at 15mph, could tip the trike onto two wheels, and after a short time in traffic you might make the chilling discovery that it had no horn. This, and several other essentials, among them indicators and mirrors, cost extra.

The early talk was of annual production of 100,000 units, but it soon became apparent that demand was vastly lower than this, and excuses for low sales began to proliferate. Within a year, it was clear that the C5 had gained about as much acceptance as Esperanto.

Yet the C5 didn't fail because of its poor range, or even because many thought it dangerous. It failed because Sinclair didn't appreciate the loss of dignity the pedallist suffered while on board. Imagine being conned into turning up at a bow-tie and dinner jacket junket in fancy dress, disguised as a clown, or perhaps a small deciduous tree. Now you begin to understand how prickly you'd feel in traffic after a while. Or even after a couple of minutes. Sinclair hadn't reinvented the car. He'd reinvented the bike.



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CAR OF THE DECADE

PEUGEOT 205

A WEEK, AS HAROLD WILSON ONCE observed, is a long time in politics. If so, six years is an eternity in the motor car business. And that's how long the Peugeot 205 has been the world's leading small car.

Just as extraordinary as the 205's period of dominance is its range of dominance. In 1.1-litre XL or GL guise, it is the world's best small shopping hatchback: a versatile little car that is comfortable and sensible to own [illegible] In its diesel guise, it is [illegible]

has never been a French priority. Yet, in late '87, a new facia was introduced, and it was a big improvement.

Even more significant, that year, was the fitment of the new TU range of petrol engines to all spark ignition models – apart from the GTI. The TU range, first launched in the Citroën AX, was gutsier, quieter, cheaper service, and more frugal than [illegible] units which [illegible]

enough to cruise at motorway speed limits. It was roomy enough to be regarded as a family car, rather than as a second car only. It handled well, rode well (ex[illegible] form – although that [illegible] excellence [illegible]

CAR MAGAZINE
JANUARY 1990.

HISTORY OR PROPHECY?

'Six years is an eternity in the motor car business. And that is how long the Peugeot 205 has been the world's leading small car.'

'The 1.9 litre GTI is the world's best hot hatchback: probably the best handling front drive car in the world, and the most entertaining.'

'In 1.1 litre XL or GL guise it is the world's best small shopping hatchback.'

'In its most recent guise – as a Cabriolet, the 205 is also dominant.'

'Just when the others were catching up, the 205 bolted convincingly into the lead. It has stayed there ever since.'

These are just some of the ways CAR Magazine lauded the Peugeot 205 when naming it Car of the Decade.

Proud? Of course we were.

But we prefer to regard such praise not so much as congratulation for the 1980s as motivation for the 1990s.

Already, the prospects are exciting.

Soon Peugeot will be launching an all-electric 205, capable of 62mph top speed and 75 miles on one recharge.

So, in ten years time, you may just see this advertisement again.

PEUGEOT 205

FOR MORE INFORMATION ON THE PEUGEOT RANGE, FREEPHONE 0800 678 800.

PEUGEOT. THE LION GOES FROM STRENGTH TO STRENGTH.

GENEROUS APPLAUSE

Let's hear it for the new Daihatsu Applause.

It is possibly one of the best equipped cars in its class, with electric windows and door mirrors, central locking, power steering, adjustable steering and stereo/radio cassette all fitted as standard.

And there's more.

What looks like the boot turns out to be a cleverly designed hatchback. Open it up and you'll find a lavish luggage area over 40 inches long (over 62 inches with the rear seats folded).

Open the bonnet of the five speed 16Xi, and you'll find an all alloy, fuel injected engine, capable of delivering a 0-60 figure of around 9.5 seconds and a top speed of 115 miles per hour.

The 16Xi is considerably more prudent when it comes to fuel consumption, however: 53 miles per gallon at a steady 56 miles per hour. (It even spares a thought for the environment, with a catalytic converter fitted as standard.)

And the cost of this stylish, comfortable, compact and superbly equipped saloon? Just £10,250.

To quote Auto Express: "Three cheers for Applause."

For more details, or to arrange a test drive, please call Daihatsu on Freephone 0800 521700 (24 hours).

DAIHATSU
APPLAUSE

The Applause 16L is £9,250, the 16Xi is £10,250. Both prices include Car Tax and VAT. Prices correct at time of going to press. Delivery and number plates extra. Automatic transmission is available for 16Xi at £700, inc. Car Tax and VAT. All Daihatsu petrol vehicles are capable of running on unleaded fuel. Official Government fuel figures: Urban: 33.2 mpg (8.5l/100 km), 56 mph: 53.3 mpg (5.3l/100 km), 75 mph: 39.2 mpg (7.2l/100 km).

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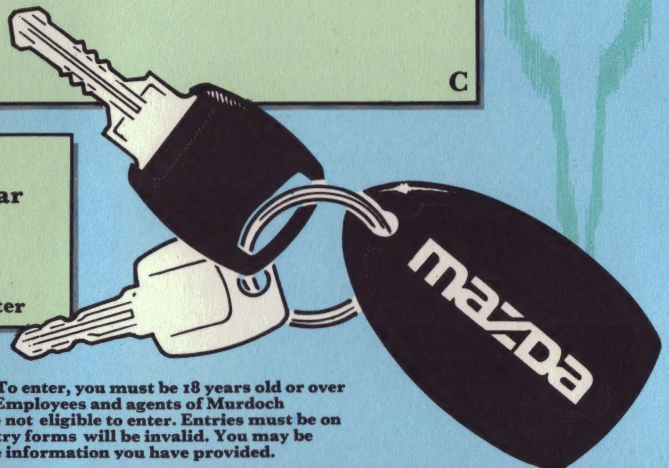

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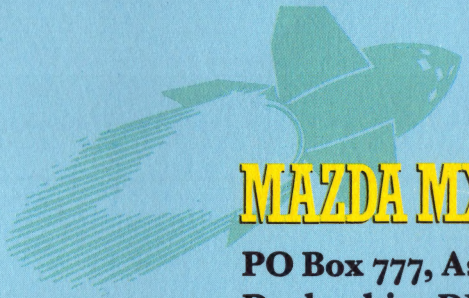

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